TUTORIAL for TPAC series

☎ 011/9664616

ME7000_14
03/11

1.0 INDEX

1.0 INDEX ---- 3
2.0 TPAC - AT A GLANCE ---- 7
2.1 FBD EXAMPLE ---- 8
2.2 LD EXAMPLE ---- 8
2.3 ST EXAMPLE ---- 8
2.4 IL EXAMPLE ---- 8
3.0 HOW TO INSTALL THE DEVELOPMENT SUITE ---- 9
4.0 HOW TO CONFIGURE TPAC ---- 9
5.0 HOW TO DEVELOP A SIMPLE PROGRAM ---- 12
5.1 TO CREATE A NEW PROJECT ---- 12
5.2 COMMON STEPS TO CREATE A NEW PROGRAM ---- 12
5.3 PROJECT DESCRIPTION ---- 13
5.4 INSERT THE IOS ---- 13
5.5 THE FBD PROGRAM ---- 14
5.6 THE ST PROGRAM ---- 16
5.7 COMPILE AND DOWNLOAD THE PROGRAM ---- 16
6.0 HOW TO DOWNLOAD A PROGRAM INTO TPAC ---- 17
6.1 HOWTO DOWNLOAD PLC PROGRAM ---- 17
7.0 HOW TO CREATE AN HMI INTERFACE ---- 18
7.1 HOW TO DISPLAY A TEXT FILE ---- 22
7.1.1 inserting a text file in an HMI project ---- 22
7.1.2 Using text file in the HMI environment ---- 24
8.0 HOW TO CONFIGURE A CANOPEN NETWORK ---- 24
8.1 EDS File List ---- 26
8.2 Insert a node in the network ---- 26
8.3 Node Configuration ---- 26
8.3.1 MECT CanOPEN Node ---- 26
8.3.2 CanOPEN Node Manual Configuration ---- 29
8.3.2.1 Administration Objects ... 30
8.3.2.2 File Info ... 30
8.3.2.3 Device Info ... 31
8.3.2.4 Object Dictionary ... 32
8.3.2.5 Parameter List ... 32
8.3.2.6 Variable List ... 33
8.3.2.7 SDO and PDO list ... 33
8.4 Object List ---- 33
8.5 Network parameter configuration ---- 34
8.6 Main Menu ---- 35
8.6.1 File Menu ---- 35
8.6.1.1 Build the configuration file ... 35
8.6.1.2 Download the configuration file ... 35
8.6.1.3 Project Save ... 35
8.6.2 Tools Menu ---- 35
8.6.2.1 Rearrange ... 36
8.6.2.2 EDS Import ... 36
8.7 Using the CANopen objects in the PLC ---- 36
8.7.1 SDO Usage ---- 37
8.7.1.1 SDORead in a PLC program ... 37
8.7.1.2 SDOWrite in a PLC program ... 38
9.0 RESETTING THE SYSTEM ---- 38

10.0 RECEIPTS ---------- 39
10.1 INTRODUCTION ---------- 39
10.1.1 Programmer side ---------- 39
10.1.2 Final User side ---------- 39
11.0 LANGUAGE MANAGEMENT IN HMI ENVIRONMENT ---------- 42
11.1 INTRODUCTION ---------- 42
11.2 STRING TABLE ---------- 42
11.3 INSERTING A NEW LANGUAGE ---------- 43
11.4 MODIFY TPAC LANGUAGE ---------- 43
12.0 SOFT KEYBOARD ---------- 44
13.0 COLOR DEFINITION HMI ---------- 46
14.0 FUNCTION BLOCKS ---------- 47
PID ---------- 47
Self tuning PID ---------- 48
32 bit up – down counter ---------- 49
32 bit up counter ---------- 50
32 bit down counter ---------- 50
Byte to bit ---------- 51
Word to bit ---------- 51
Word to byte ---------- 52
Double word to byte ---------- 52
MUX_8_x_1 multiplexer 8 per 1 ---------- 53
COMPARE ---------- 54
GAIN ---------- 55
FF_D: D flip-flop ---------- 55
FF_T: T flip flop ---------- 56
Date_ Read: read the current date ---------- 56
Time_ read: read the current time ---------- 56
TimeE_write: write the current time ---------- 57
Date_write: write the current date ---------- 57
ONE_SEC: one second pulse ---------- 58
pulse ---------- 58
pulses ---------- 58
pwm ---------- 59
freq_div ---------- 59
digital_in_filter ---------- 60
chrono ---------- 60
timer_retrig ---------- 61
timer_rit_ecc ---------- 62
timer_rit_dis ---------- 63
timer_coil ---------- 64
r_trig ---------- 64
Set_Reset ---------- 65
start ---------- 65
stop ---------- 65
Cell (Only TPAC 02 cell version) ---------- 66
14.1 Embedded Functions ---------- 66
15.0 HOW TO CONFIGURE TPAC THROUGH THE WEB INTERFACE ---------- 68
15.1 Preface ---------- 68
15.2 Open TPAC web interface ---------- 68
15.3 Configuration ---------- 70
16.0 FUNCTIONS ---------- 73
16.1 IMMEDIATE FUNCTIONS ---------- 73

16.2 DELAY FUNCTIONS---- 74
16.3 TIMERS---- 75
16.4 VIDEO CONTROL FUNCTIONS ---- 75
16.5 RECEIPTS FUNCTIONS---- 77
16.6 DATE AND TIME FUNCTIONS ---- 83
16.7 MECT SERIAL FUNCTIONS ---- 83
16.8 MODBUS Functions---- 85
16.9 CanOpen FUNCTIONS ---- 91
16.10 HMI TEXT FILE IMPORT FUNCTIONS---- 93
16.11 DATALOGGER ---- 93
16.11.1 CRYPTO-DATALOGGER – CFR21/11 ---- 96
16.12 STRINGS MANIPULATION FUNCTIONS---- 98
16.13 DATE FUNCTIONS ---- 98
17.0 TPAC Remote Options---- 99
17.1 Remote Desktop ---- 100
17.2 Remote Desktop Access ---- 100
17.3 Setting Remote Desktop Password---- 101
17.4 Monitor---- 101
17.5 Variables Upload ---- 101
17.6 Monitor Access ---- 103
17.7 Remote PLC---- 104
17.8 PLCLIB Description ---- 104
17.9 Functions---- 106
17.10 Working with PLCIB in a Turbo C++ environment ---- 108
17.11 VPN ACCESS CONFIGURATION ---- 108
17.12 PKI setting up---- 108
17.13 Certification authority ---- 109
17.14 Session key---- 109
17.15 TPAC certificate and private key ---- 110
17.16 Client certifcate and key ---- 110
17.17 TPAC VPN Configuration---- 110
17.18 Client VPN Configuration ---- 110
17.19 TPAC VPN address---- 111
18.0 USB ALLOWED OPERATIONS---- 111
19.0 APPENDIX 3---- 112
19.1 Software Registration ---- 112
19.2 Registration code request for LogicLab, PageLabe and NetBuilder ---- 112
19.3 LogicLab and PageLab registration---- 113
19.4 NetBuilder registration---- 113
19.5 Software update---- 114
19.5.1 System software update---- 114
19.5.2 Services software update---- 114
19.5.3 User software update ---- 114

2.0 TPAC - AT A GLANCE

TPAC has many peripherals, that may be divided in four sets (see the user manuals for details):

1. local control IO
    - PNP digital input 0-24V
    - PNP digital output 0-24V
    - Analog input 0-20mA, 12 bits resolution; max sample rate 500 samples per second
    - Analog output 4-20mA, 12 bits resolution, refresh frequency 500Hz
    - Incremental encoders, max count 2^{28}
    - rpm
2. remote control IO
    - 2 CAN channels 1 Mb/sec with CAN OPEN protocol.
    - 1 RS485 or 1 RS232, 115kbit per second
3. TPAC ports
    - 1 LAN port 10Mbit per second
    - 1 USB 1.0 port master

4. Human Machine Interface
    - LCD 320 x 240 color STN
    - Touch screen interface
    - 16 keys keyboard

A description of the TPAC port usage in a PAC project is given below.

The shortest PLC cycle may be 1ms, the timer accuracy is ± 30µs. Time Cycle must be configured by user.

A TPAC program is composed by two elements:

1. PLC program built by the Axel LogicLab software
2. Human Machine Interface developed using the Axel PageLab software

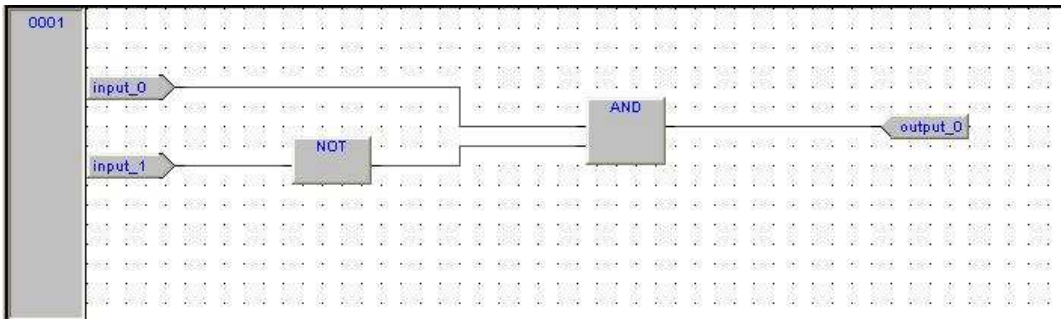
A PLC program may be developed in the following IEC 61131-3 compliant languages:

FBD	Functional Block Diagram	Graphical	Like electric schematic
LD	Ladder	Graphical	Ladder schematic
SFC	Sequential Function Chart	Graphical	States diagram
ST	Structured Text	Textual	Pascal-like language
IL (AWL)	Instruction List	Textual	Assembler-like language

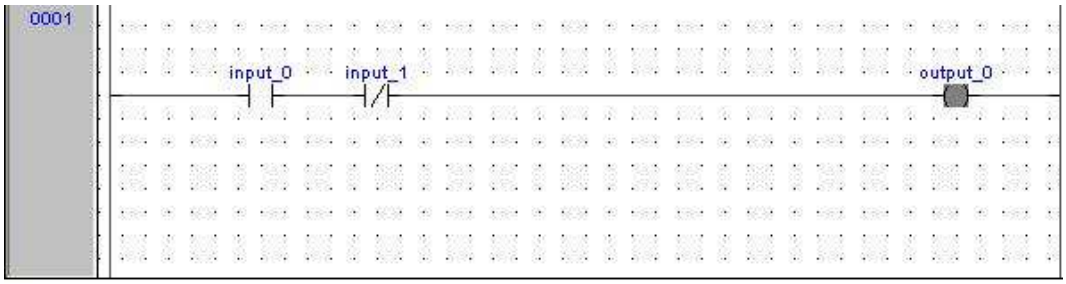
To illustrate the various languages, a very simple program is developed.

The program sets output_0 to 1 when the logic input_0 is set to 1 and the logic input_1 is set to 0.

2.1 FBD EXAMPLE



2.2 LD EXAMPLE



2.3 ST EXAMPLE

```
IF INPUT_0 AND (NOT INPUT_1 ) THEN
        OUTPUT_0:=1;
ELSE
        OUTPUT_0:=0;
END_IF;
```

2.4 IL EXAMPLE

```
START:
        LD      INPUT_1
        XOR     INPUT_1
        AND     INPUT_0
        ST      OUTPUT_0
```

Further details about programming languages will be provided throughout the tutorial. (see section “Develop a simple program”).

3.0 HOW TO INSTALL THE DEVELOPMENT SUITE

TPAC is supplied with a CD containing the software that a user must install into a Windows system based personal computer.

The supplied software is

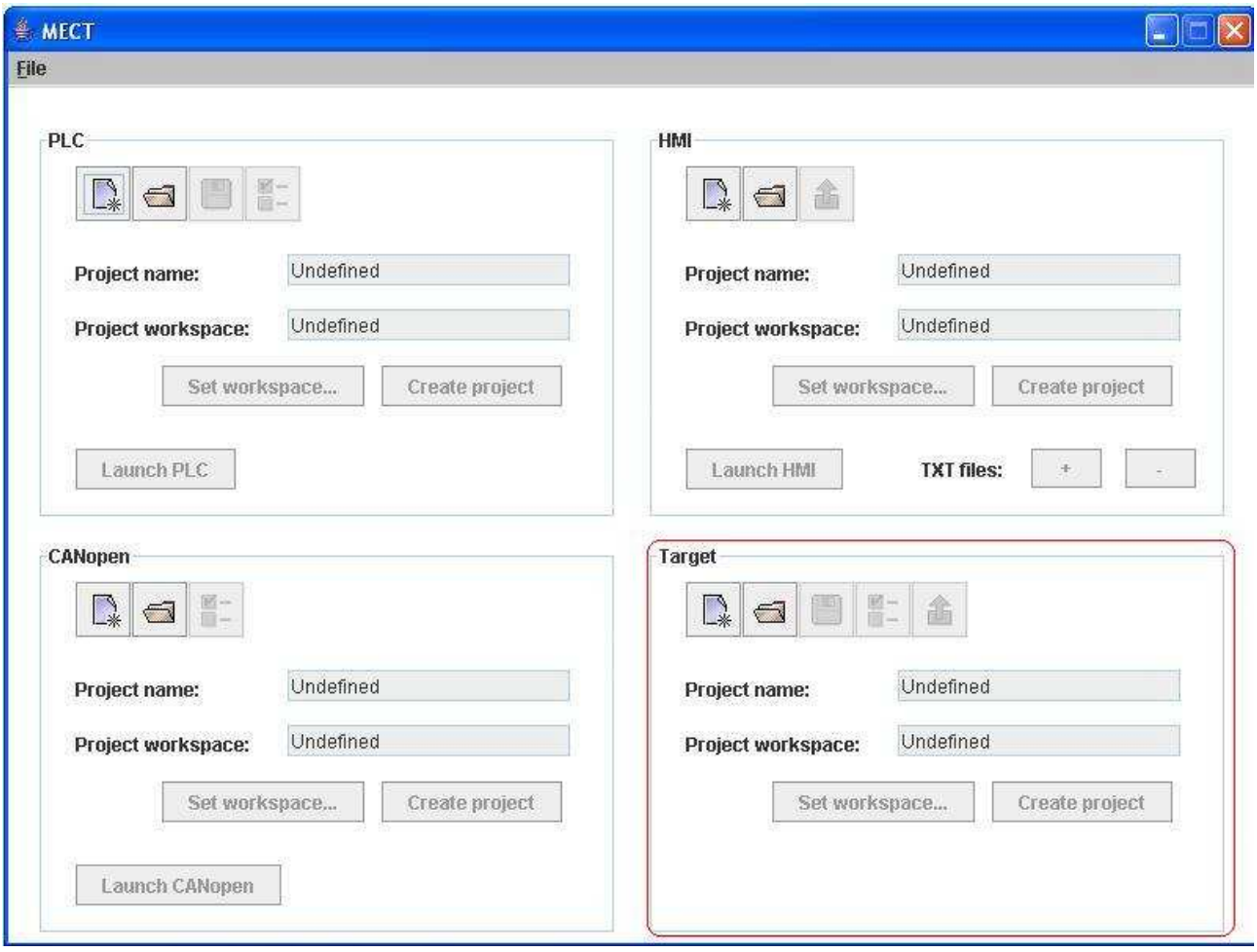
- Mect Dashboard
- Axel LogicLab: PLC software
- Axel PageLab: Human Machine Interface software
- Axel LLComp: communication software to download the PLC program into TPAC
- Trama Netbuilder: CanOpen netbuilder
- Microsoft Windows .net framework 2.0: needed if not already available on the PC
- SUN J2SE runtime.

To install the entire suite from CD execute TPAC.exe that leds to a guided installation procedure.

Once the installation is completed an icon named TPAC is placed on the desktop. The installed software needs to be registered, please refer to Appendix 3, for information about the registration procedure.

4.0 HOW TO CONFIGURE TPAC

Before any project development, executing the TPAC dashboard configures the TPAC.



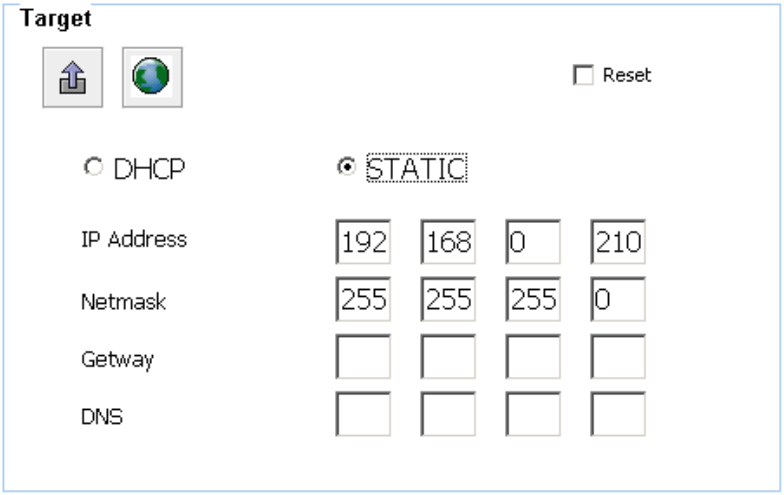
To create a new project in the PLC section click on the new project icon and select the model of hardware for which you are creating the project. The button "Set Directory"allows you to set the path on your hard drive where the project will be created. Fill in the "Project Name" field with the name of the project and then click on "Create Project". To start the programming environment, press "Start PLC".
In the Target box the following buttons are available:

- **Export current configuration** save on a USB device or on the local file system the current network configuration or the reset configuration.
- **Launch web browser** Starts the web browser and connects to the TPAC by the local area network using the configuration specified **as "Net Configuration"**

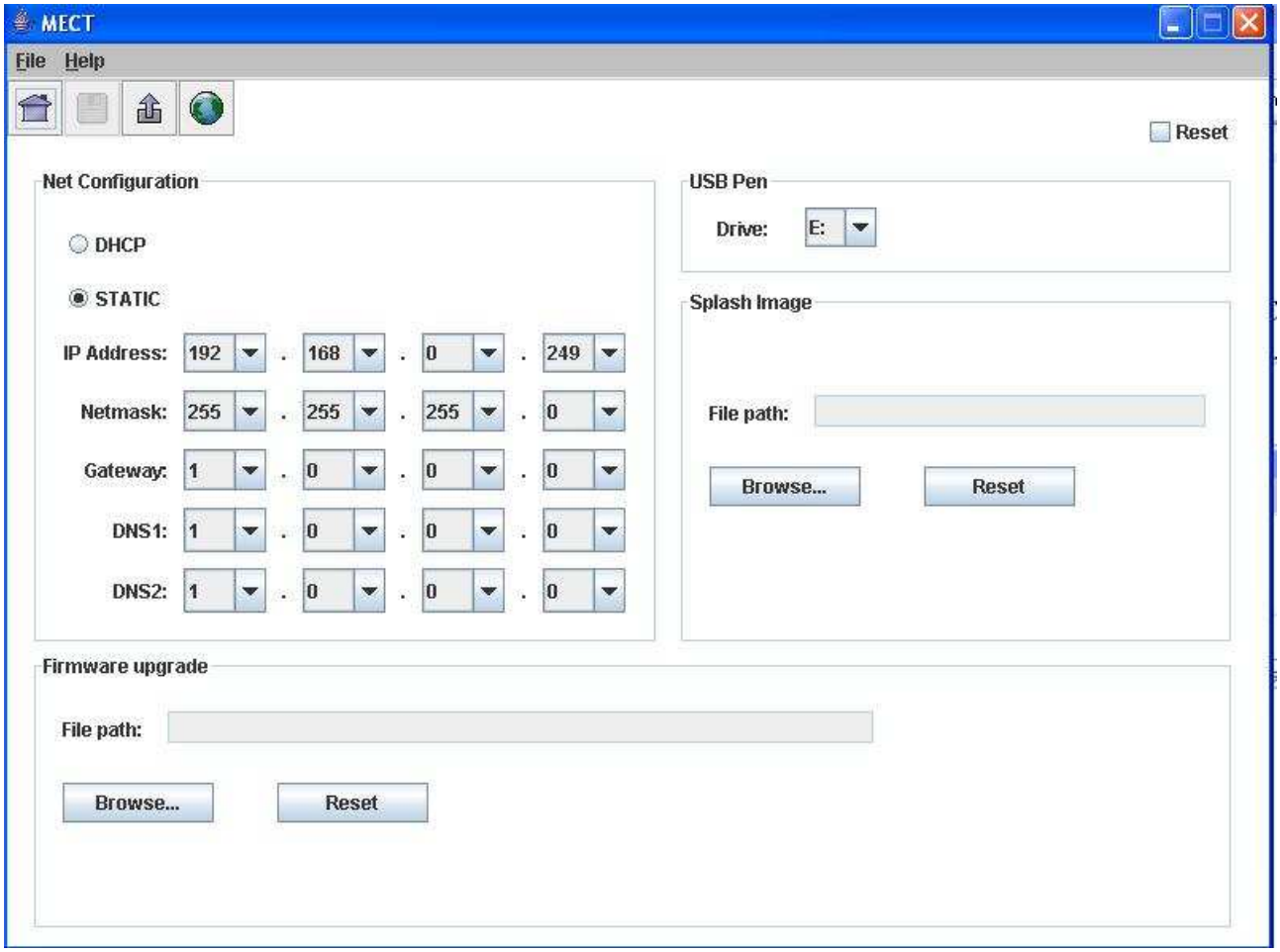
In the same box the LAN configuration can be set and eventually, if the need arises, the flag that restores the original settings for the system can be selected.
To restore factory settings see chapter "Reset the system. "

The network configuration is a must for the TPAC since all programming software works through LAN. Choose "DHCP" if in your LAN network a DHCP server automatically releases IP addresses; select "STATIC" if the DHCP server is not present or you prefer a static IP address assignment. In the latter case you must insert the IP address you plan to use.

NOTE: If the TPAC IP address is set by a DHCP server, the leased address must be known, since needed by all software programming tools.



The network settings or the reset configuration can be saved on a USB device or on the local file system using the "Export current configuration" that will create a file, respectively:
"Net.conf" including the LAN setup or "reset.conf" containing the reset settings.
Once the configuration file is saved on the USB device, to configure the
TPAC just insert the USB device in the USB slot and switch on the TPAC. The TPAC will load the newc onfiguration that will be active from the next reboot.
Once the TPAC got its configuration it becomes ready to be programmed.



The Settings window in the high left corner displays four buttons:

- **Back to the homepage** (back to the previous page)
- **Save configuration** (save current configuration on the hard disk)
- **Export current configuration** (save current configuration on a USB pen drive)
- **Launch web browser** (Start a web browser and connect to the TPAC by IP the address defined in the **Net configuration**)

Besides the aforementioned buttons the Settings window offers five sections:

1. Net Configuration (LAN network set up)
2. Splash Image (system start up image)
3. USB Pen
4. Firmware Upgrade
5. Reset

In the first section you can set the TPAC network IP address. Choose “DHCP” if in your LAN network a DHCP server automatically releases IP addresses; select “STATIC” if the DHCP server is not present or you prefer a static IP address assignment. In the latter case you must insert manually in the Net Configuration window the IP address you plan to use.

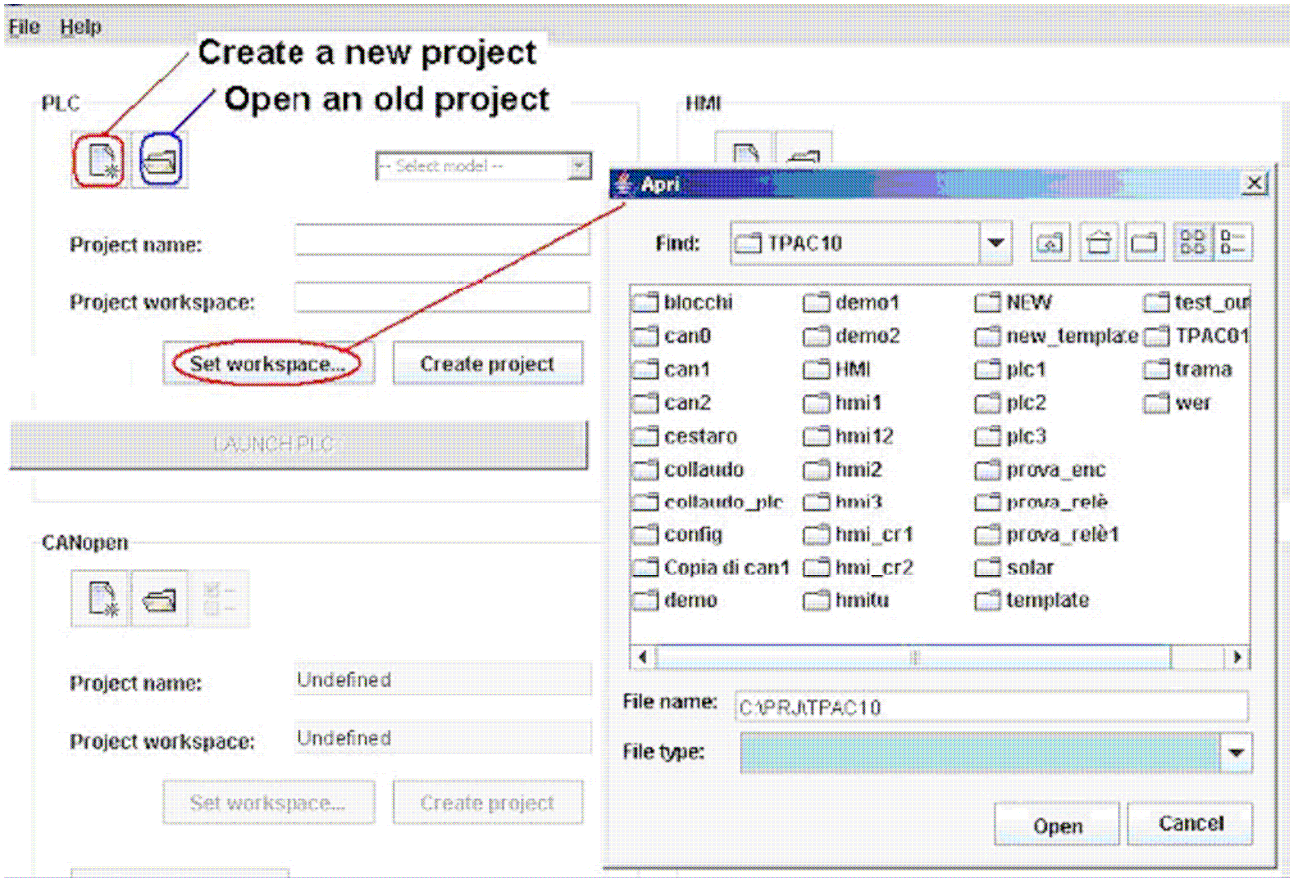
NOTE: If the TPAC IP address is set by a DHCP server, the leased address must be known, since needed by several configuration procedures.

5.0 HOW TO DEVELOP A SIMPLE PROGRAM

TPAC may be programmed in five IEC 61131-3 compliant languages. This tutorial covers a simple program with all these languages.
A new project needs to be defined before developing a program.

5.1 TO CREATE A NEW PROJECT

The Dashboard main window, through section **PLC,** allows users to create new projects. First select the project target hardware and click on the **New project** button (the one circled in red) and then click **Set workspace**, this will display a window to select the project destination directory.

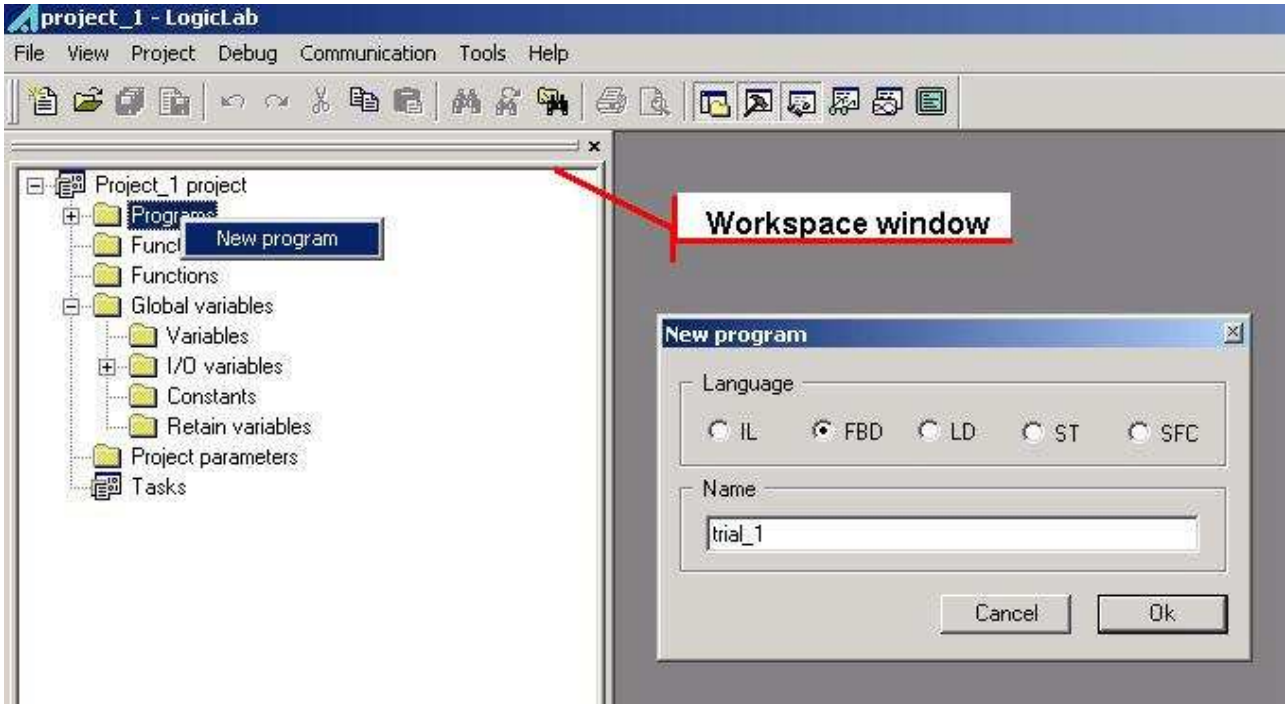


Once selected the destination folder press **Open**, insert the name of the project to be created by filling the **Project name** field. Press the button **Create project** to complete the project creation step.

Press the **launch PLC** button to start with programming, it will activate the PLC programming environment.

5.2 COMMON STEPS TO CREATE A NEW PROGRAM

To create a new program select **Programs** in the **Workspace window** (left side of the main window), then right click it and a **New program** tag is displayed. Left click the tag and a **New program** window will show up, as in the following figure.



This window allows the programming language selection. The project exemplify first the graphical language, then we'll go through the textual ones.
Hence choose the FBD (Function Block Diagram) as the programming language, insert the program name and then click **OK**.
You are ready to input the project.

5.3 PROJECT DESCRIPTION

The implemented project consists in an on-off pressure regulator. The pressure in a room has to stay between two thresholds. If the pressure is over the high threshold (threshold_1), it is reduced by setting output 0 to logic 1, leading to a discharge valve opening. If the pressure is below the low threshold (threshold_2), it is incremented by setting output 1 to logic 1. A digital input enables to operation the pressure regulator.

5.4 INSERT THE IOS

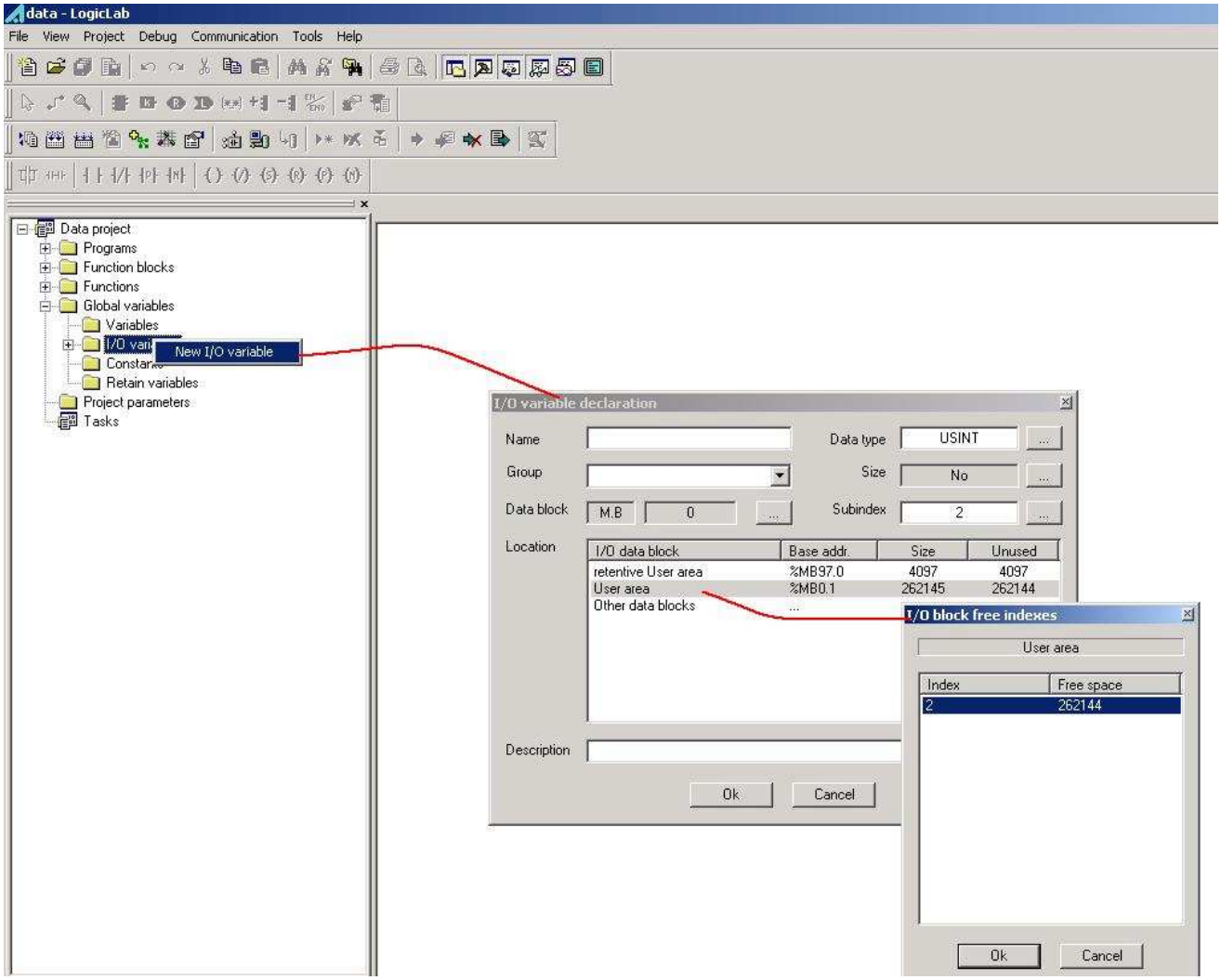
The first step is the PLC IOs configuration. From the project description we require: an analog input (pressure measurement), two digital outputs (valve opening) and one digital input (the enable).

The PLC accesses the TPAC IO pins through input and output state variables. These IO variables are already defined in the TPAC template. Thus the first step is to map the project IOs to the PLC variables as listed below:

- the project output 0 to the output variable **DO_1**, which is directly connected to the output 1 on the rear terminal block of the TPAC;
- the project output 1 on the **DO_2** variable, directly connected to the output 2 of the TPAC;
- the project enable input to **DI_1;**
- the project analog input to **ANALOG_INPUT_1**.

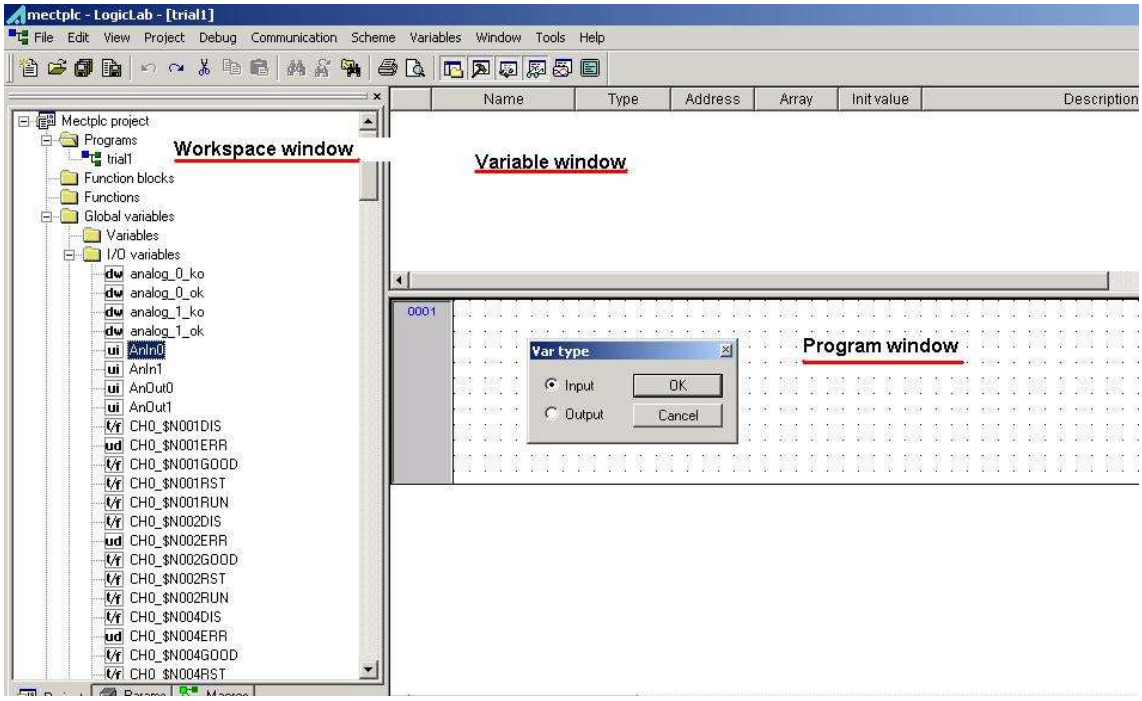
Next step is to define the threshold variables **threshold_1** and **threshold_2**. In the **workspace window** select the folder **I/O variables**, right click to pop up the tag **New I/O variable** then left click it to show up the **I/O variable declaration** window.

Click over the **User area** row to view the **I/O block free indexes** window. By clicking twice on the showed row, the variable will be assigned to that memory location, this avoids memory variables overlapping. Type the name of the variable (threshold_1) in the field **Name** of the **I/O variable declaration,** and click **OK;** the variable will be created and available to the program. By the same procedure assign threshold_2 variable.

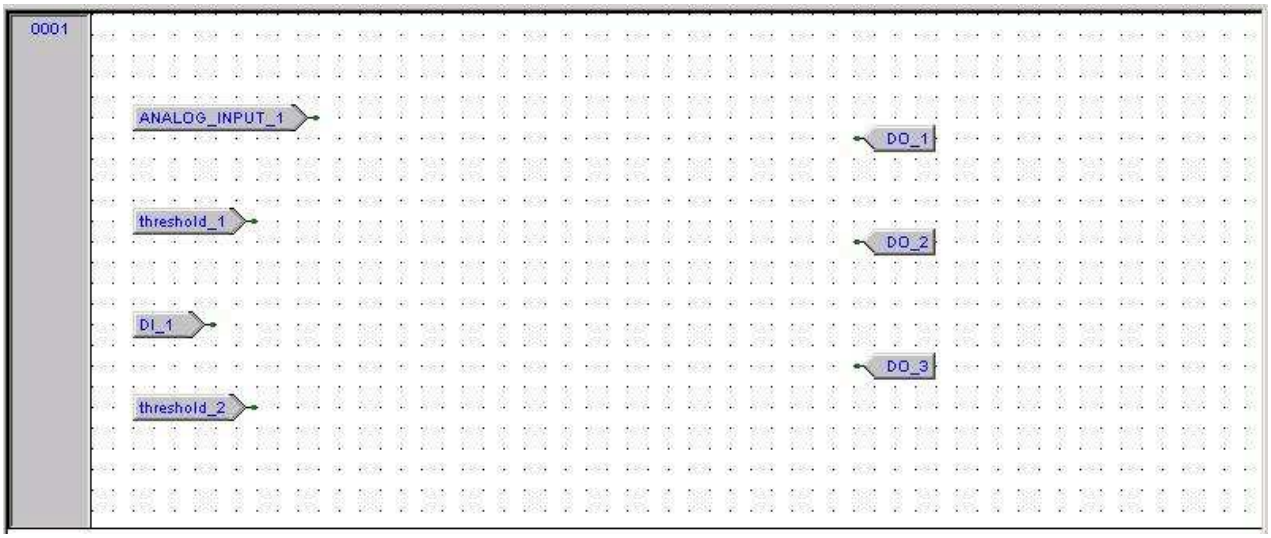


5.5 THE FBD PROGRAM

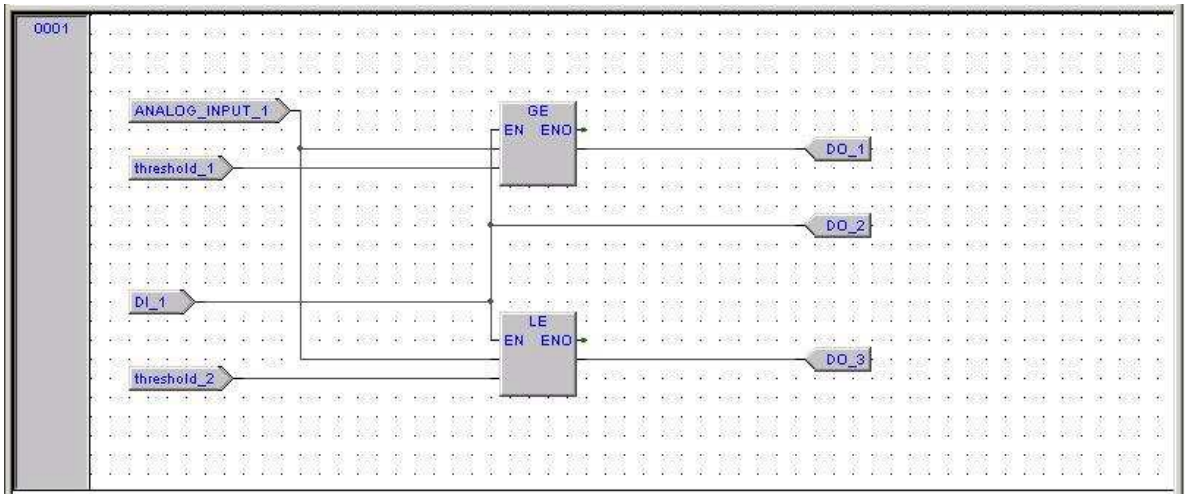
In the **workspace window** expand the **I/O variables** tree. In this tree select which input or output to use, then drag and drop it into the **program window**. The software will ask if the selected variable is an input or an output. Choose the right type and then press **OK**.



Perform the same operations for the internal variables, **threshold_1** and **threshold_2**.
In the **program window** you'll see the pads corresponding to the selected inputs and outputs.



After positioning the IOs and the variables in the **program window**, they have to be connected to the functional blocks that implement the program behavior.
In the **library window** select the **Operator and standard blocks** tab. If the library window is not active, activate it by typing Ctrl+L or select **View->Library** in the main window menu.
You can select the needed functional blocks, drag and drop them into the **program window** to obtain a layout similar to the one illustrated below. If the needed functional block is not available in the system functional blocks set, you can access an additional set of functional blocks created by MECT. To list these blocks, select the **Function blocks** entry from the **workspace window.**. For details about functional block, please refer to the section: **Functional Blocks**.



Finally, we need to draw the wiring that properly connects the elements. This is achieved by right clicking in the **program window** and selecting **Connection mode** from the pop up menu that appears. The cursor changes shape to mean that now we can draw the connections between the elements of the diagram. For instance, click first on the connection pin of the **DI_1** input and then on the connection pin **EN** of the **GE** functional block. A connection wire should be drawn between the two pins. Repeat these operations until you wire all the elements as shown in the figure above.

At this stage the program is ready to be compiled and downloaded the on the TPAC, as will be described in the section **Compile and download the program**.

5.6 THE ST PROGRAM

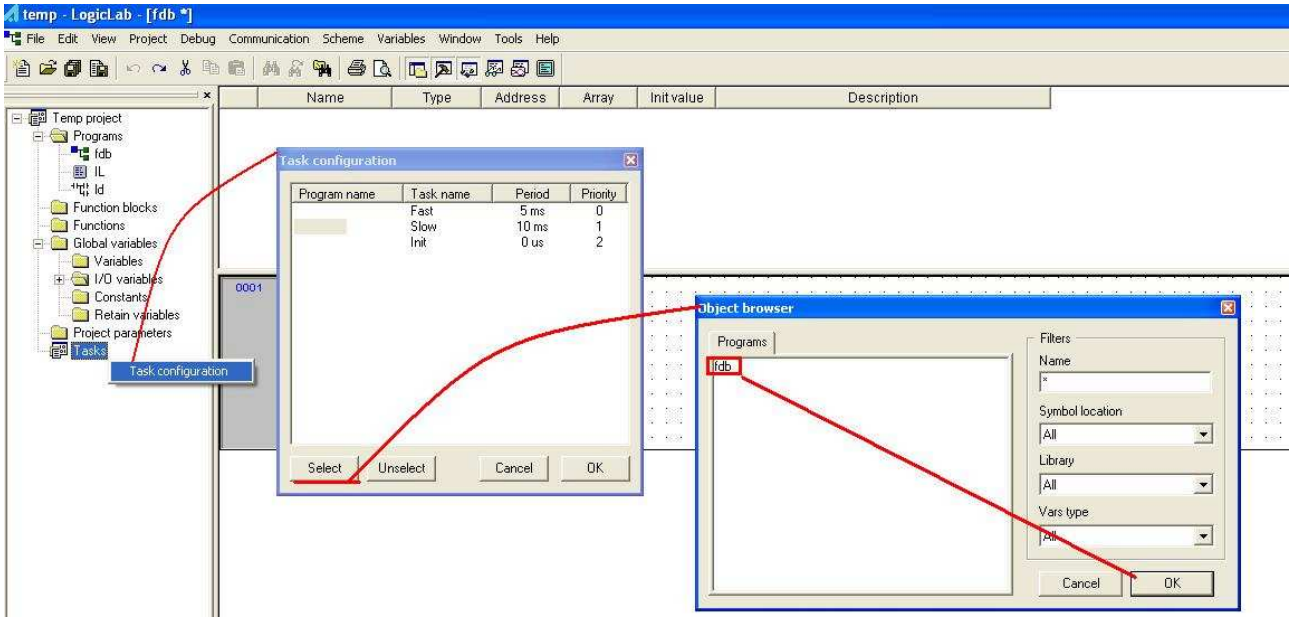
The same functionality can be implemented using the following code in the Structured Text language. Repeat the steps described in the section **Common steps to create a new program** and select **ST** instead of **FBD**.

```
IF DI_1 = 1 THEN
        DO_2 := 1;
        IF AnIn0 >= threshold_1 THEN
                DO_1 := 1;
                DO_2 := 0;
        ELSIF AnIn0 <= threshold_2 THEN
                DO_1 := 0;
                DO_2 := 1;
        END_IF;

ELSE
        DO_1 := 0;
        DO_2 := 0;
        DO_3 := 0;
END_IF;
```

5.7 COMPILE AND DOWNLOAD THE PROGRAM

Before being able to compile the program, it must be assigned to a task. To this purpose select **Task** in the **workspace window**, by right click, then click on the **Task configuration** tag that shows up. In the column **Program name** of the **Task configuration** pop up window, select the task

to be assigned to the program, then press **Select.** An **Object browser** pop up window shows up. Select the program name and press **OK** to validate the choice and close the window.



Once the program is assigned to a task we can proceed to compile and download it into the TPAC.

To compile the project, select **Recompile all** in the menu **Project**. The compilation progress and log can be monitored in the **Output window**.

If the program has been modified since the last download on the TPAC or a new project was loaded, DIFF. CODE will be displayed in the right end of the status bar of the main window. In this case, to update the program on TPAC, select **Download code** in the **Communication** menu. In the **Output window** is logged the result of the download operation.

6.0 HOW TO DOWNLOAD A PROGRAM INTO TPAC

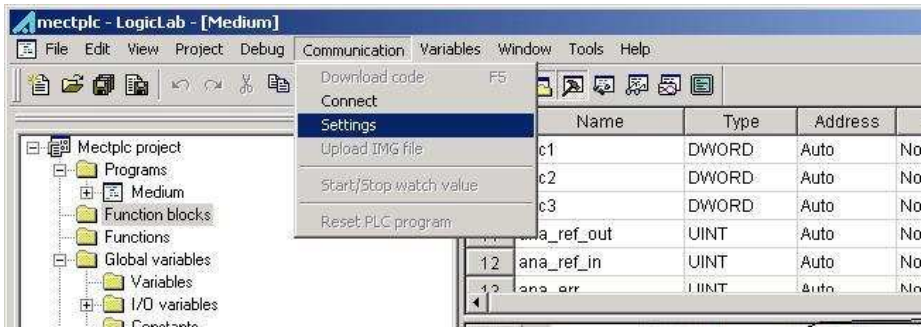
Before downloading a program into TPAC, a communication link between the target (TPAC) and the personal computer with the development environment has to be established.

It's necessary to connect the target to a personal computer using the TCP/IP network.

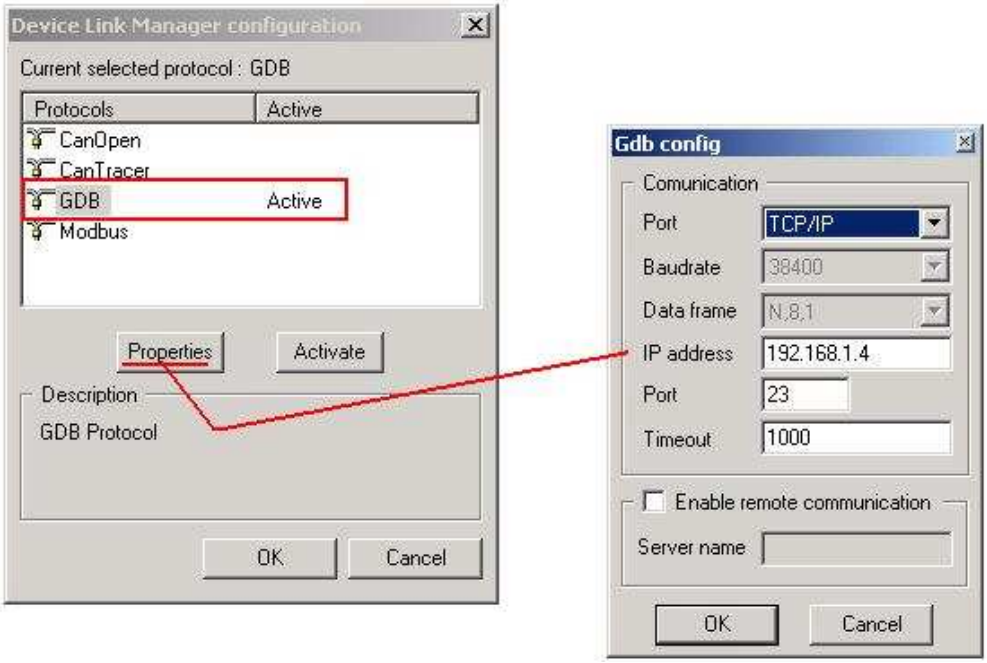
6.1 HOWTO DOWNLOAD PLC PROGRAM

Prerequisite:

- the TPAC IP address must be known.
- Setup the communication parameters of the development environment using the TPAC IP address.



Choose **Settings** from the **Communication** menu. In the **Device Link Manager Configuration** window select the **GDB** protocol. If it's not active, press the **Activate** button. Next click on **Properties** and the **GDB config** window shows up. Select as Port: TCP/IP set the IP address to the address of the TPAC. Set 5000 as port number, and leave all other parameters unchanged. Click **OK** on both pop-up windows.



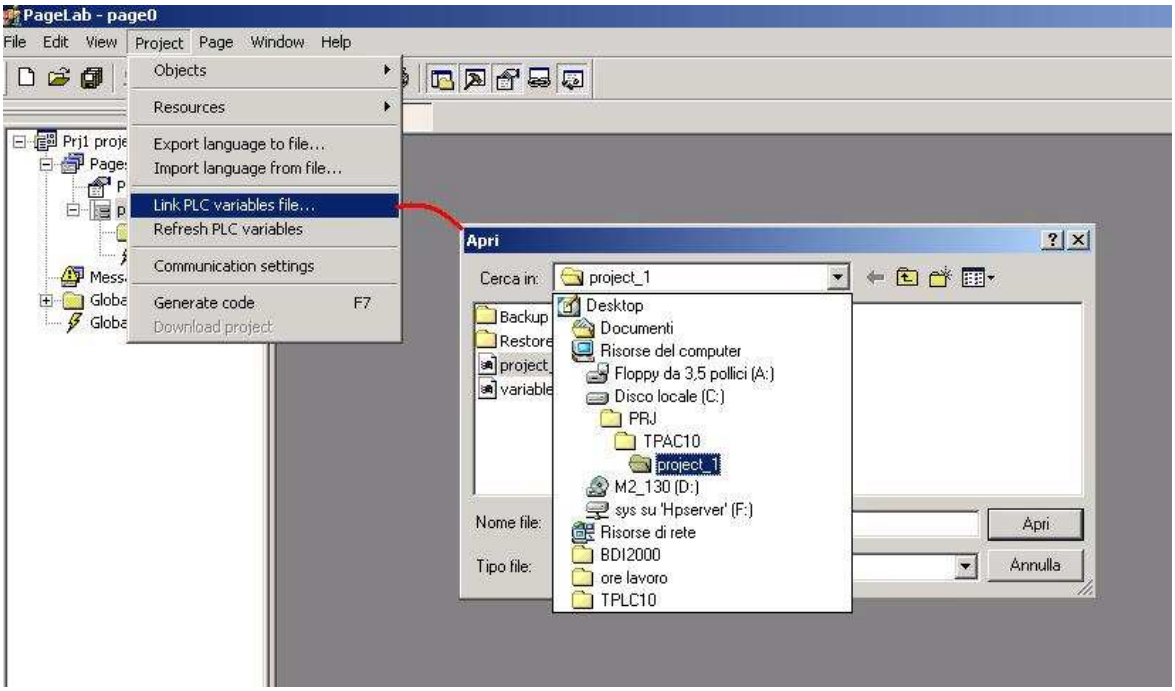
Now we're ready to connect to the TPAC. In the **Communication** menu of the main window, select **Connect**, to establish a connection between the target and the PC. When a link is up, on the right of the status bar of **LogicLab** you'll see:

- DIFF. CODE, meaning that a connection is established but the code on the TPAC is different from the one in the development environment.
- CONNECTED meaning that a connection is established and the code on the TPAC is the same as the one in the development environment.
- ERROR meaning that there is a problem with the connection between the TPAC and the development environment.

7.0 HOW TO CREATE AN HMI INTERFACE

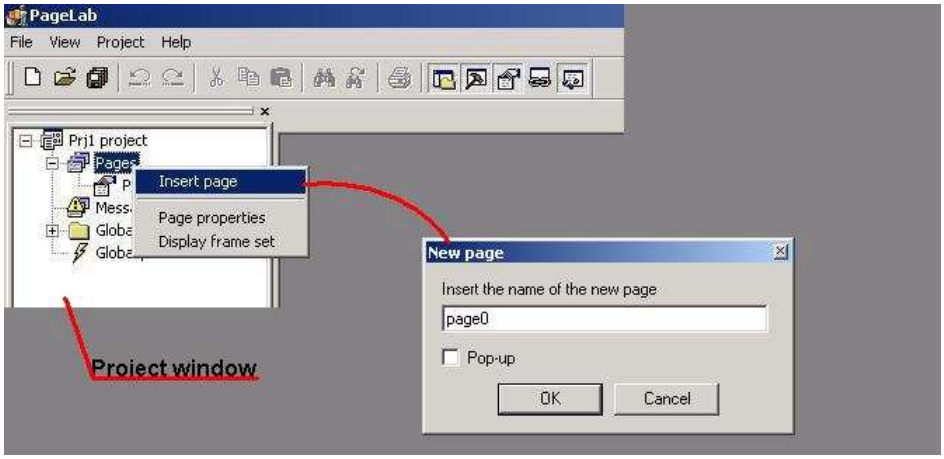
When a PLC program has been created, we may need to develop also an HMI interface. From the dashboard create a **New project** as explained for the PLC. To launch the project (or to open an existing one), press the button **Launch HMI**: the HMI developing environment begins.

NOTE: Before starting the PageLab HMI designer needs to be linked with the TPAC variables defined in the TPAC project. To this aim select **Link PLC variables file…** in the menu **Project.** Then find in the PLC project folder the .exp file, select the file and click open. The IO variables created in the TPAC development environment are now visible in the HMI project.



As done for the PLC project, we first need to define the communication parameters with the TPAC. Select the menu **Project->Communication settings**, then follow the steps described in section **How To download PLC program**.

To begin the HMI project we define a new page. In the **project window**, select **Pages** right click on it, then left click on the **Insert page** tab in the pop up menu that appears. In the **New page** pop up window insert the name of the page and then click **OK** button, as in the figure below.



To display the page layout canvas, click twice on the Page name in the **Project window**. A blank page will show up and you can start populating it with the available elements.

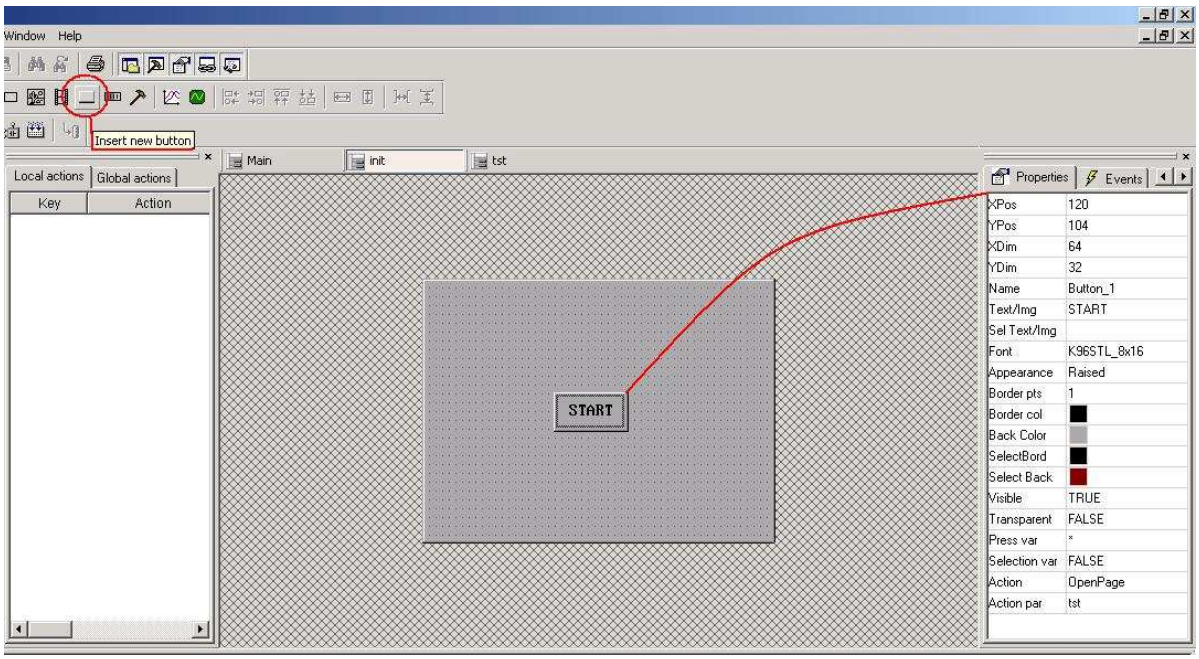
To insert an object into the page select the element to be inserted from the **Page** menu. The available objects are:

- Static
- Image
- Animation
- Edit
- Button
- Custom control

For our project we will define two pages: a welcome page and an operative page.

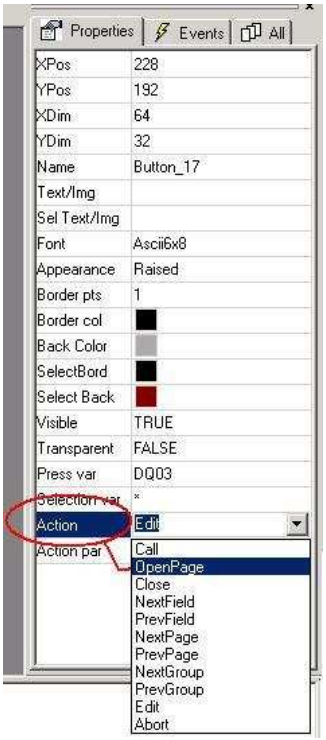
The welcome page has three elements: two static objects and one button and looks like the following picture.

To insert the button, select the **New Button** entry in the **Page** menu, then place the button on the page, in the desired position. The right part of the main window will list all the properties of the button element. These properties can be edited to suit your needs.



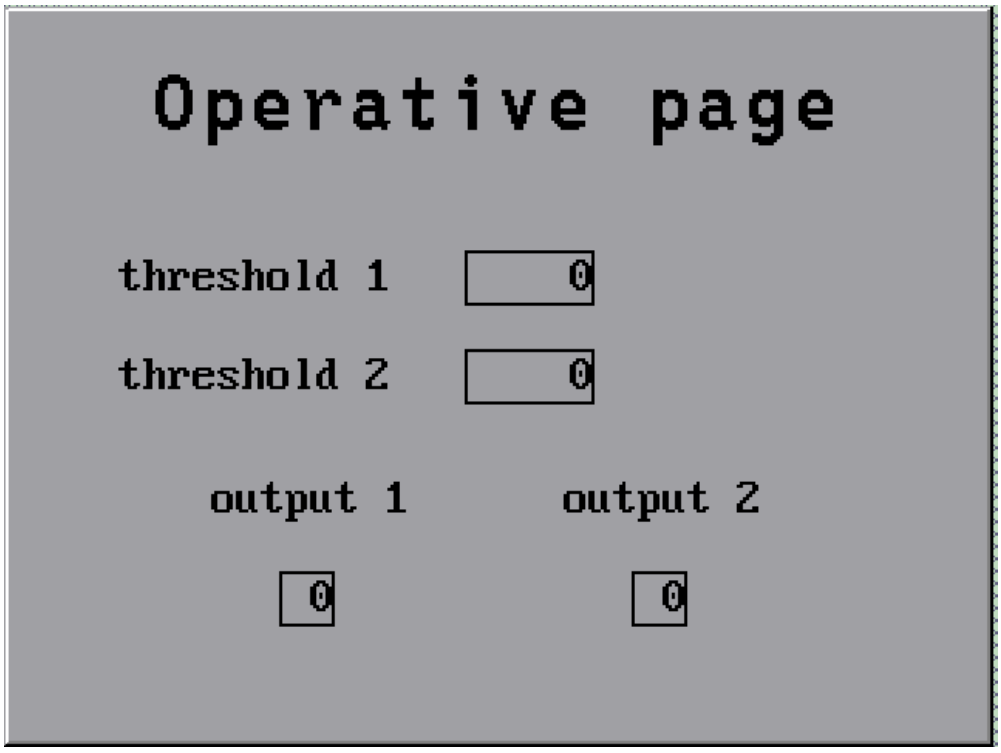
Among the most important elements of a button there's its action. To assign an action select the row **Action,** then the action to associate from the drop down menu. In our example, we want that the

button opens the operative page, hence we select the **OpenPage** entry as shown in the figure below.

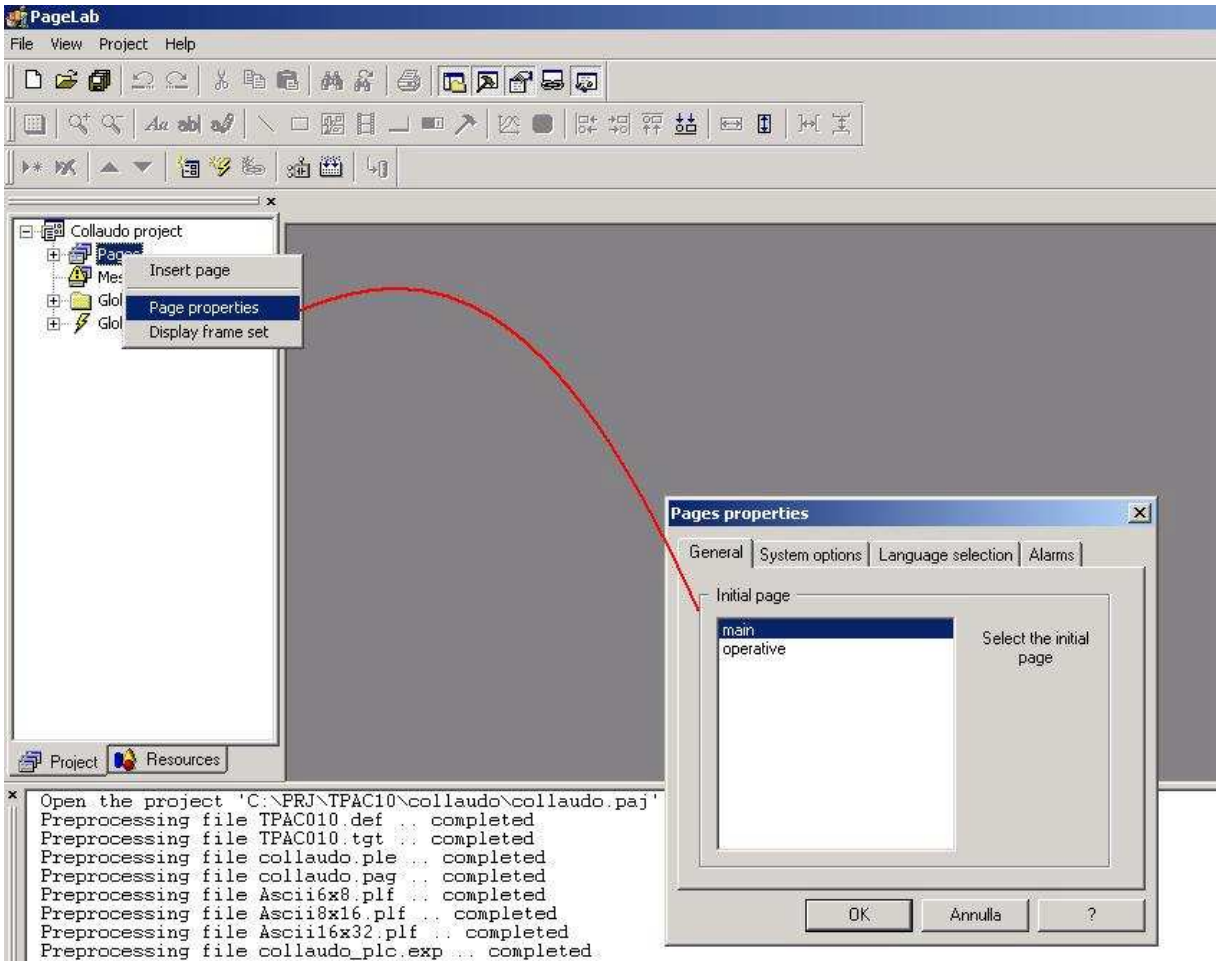


As depicted for the button example, we may insert others elements, such as static labels or images.

The operative page has more objects than the welcome one. There are five static labels, two input fields and two output objects. The properties of objects are inserted in the same way as described for the button element above.



Before compiling the project, we need to set the page from which the visualization starts. From the **project window** select **Pages**, and right click on it, then left click on the Page proprieties label in the pop-up window. In the **Page properties window**, select **General**, then from the pages list, select which page to use as the first, then press **OK**.



When all the pages are defined, the project can be compiled. From the menu **Project** select **Generate code**, which compiles the project**.**

Before being able to download the project into the TPAC a connection has to be established with it, in the same way as for the LogicLab environment.

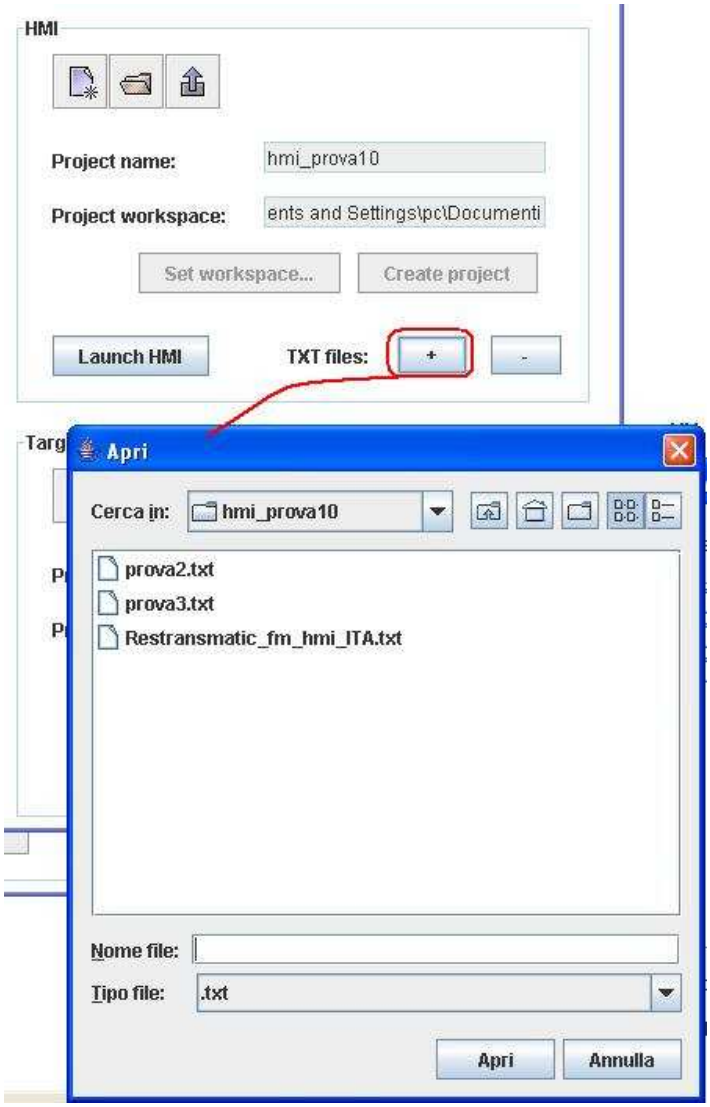
Once the connection is established code download occurs by selecting **Download project** from the **Project** menu.

7.1 HOW TO DISPLAY A TEXT FILE

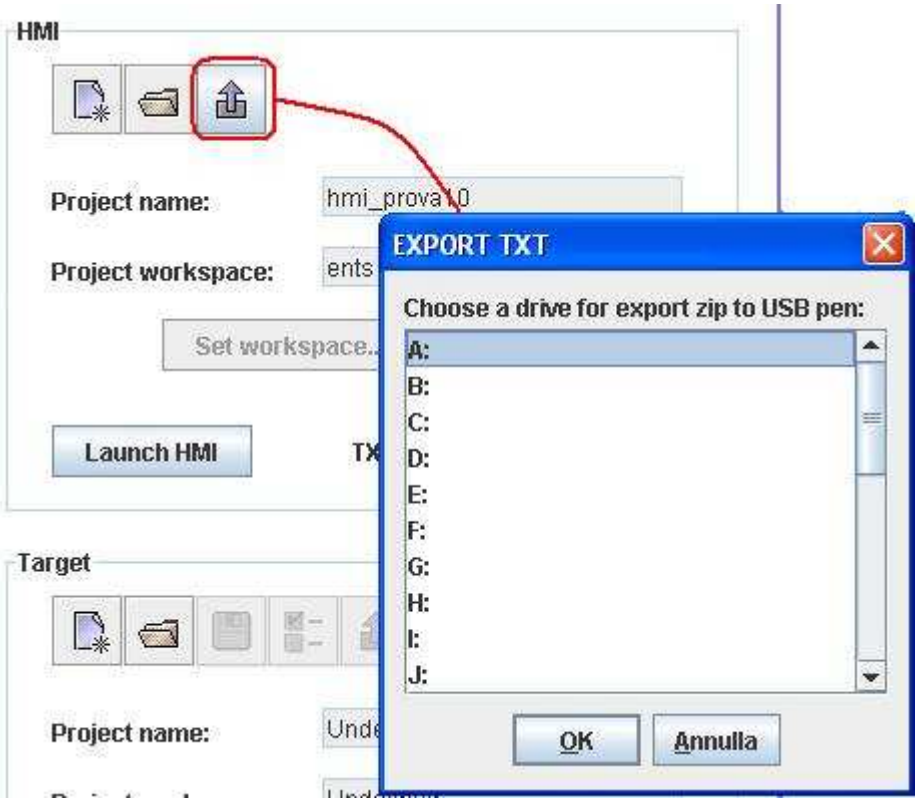
A HMI project may require static text, like help instructions, to be viewed on the screen.
Such kind of information cannot be stored in the retentive variables since they have a different role.
The programmer can display one or more text files stored on the TPAC flash through the **HMItextLoad**() function.

7.1.1 inserting a text file in an HMI project

A text file can be uploaded into a HMI project by clicking the + button in the dashboard HMI section and picking the selected file. To cancel a text file click on the - button and chose the file to be deleted.



When all needed files have been selected by clicking the button the user is prompted to chose the logical drive that maps the USB pen; the text file archive will be saved on that drive after pressing the OK button.



By plugging the USB pen into the TPAC and rebooting the device the text files will be transferred on the TPAC flash drive and made available to the programmer.

7.1.2 Using text file in the HMI environment

Text files are manipulated through the **HMItestLoad**('file_name') function. This function searches for the file with the specified file name and returns an error code. If the returned code is 0 the function was successful and the **HMI_LOAD** variable contains the returned file pointer.
The following code details an example for the **HMItestLoad** function:

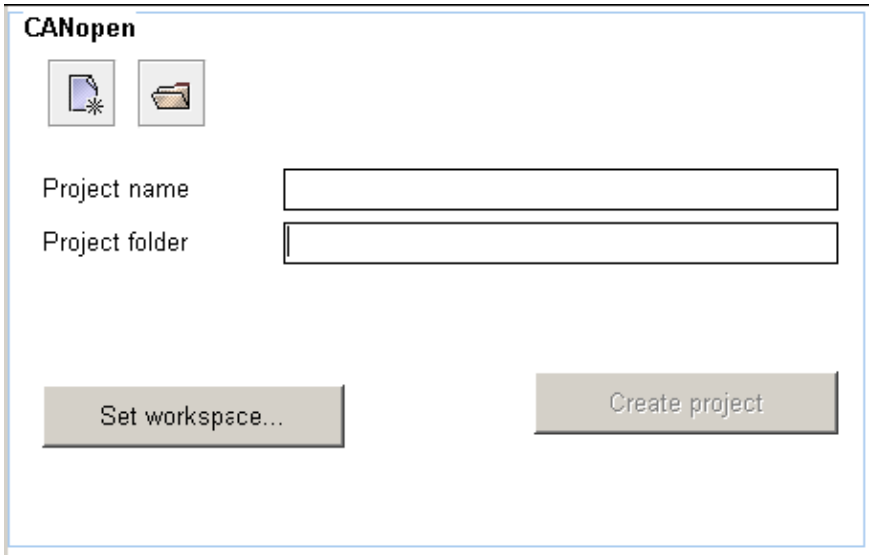
```
res:=HMItextLoad('instruction.txt');

IF res = 0 THEN
        output:=FILE_READ;
ELSE
        output:='File not available';
END_IF;
```

HmitestLoad looks for the file named "instruction.txt". If the file exists, res is 0, hence ouput (declared as a 1000 character string) contains the file pointer returned by the function. By assigning output to a HMI text box the file content is displayed on the screen.

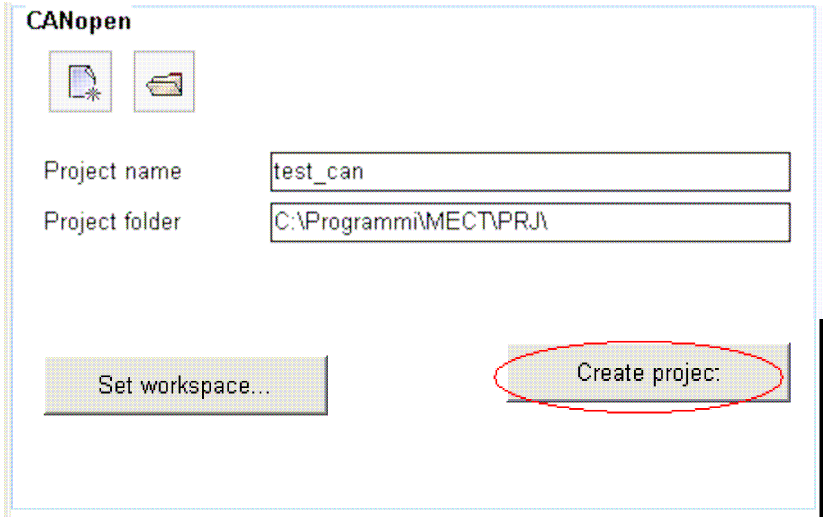
8.0 HOW TO CONFIGURE A CANOPEN NETWORK

The TPAC works as CanOPEN master device hence a number of CanOPEN node devices can be connected to the master in order to build a CanOPEN network. These CanOPEN node devices must be configured and the configuration parameters with the master must also be set. The previous mentioned configuration are set through a specific software that depends from the CanOPEN master hence it is bounded to the TPAC. Mect provides the Can Builder CanOPEN network configurator.

If you want to manage a CANOpen network, from the CANOpen section of the dashboard, create or open a project.

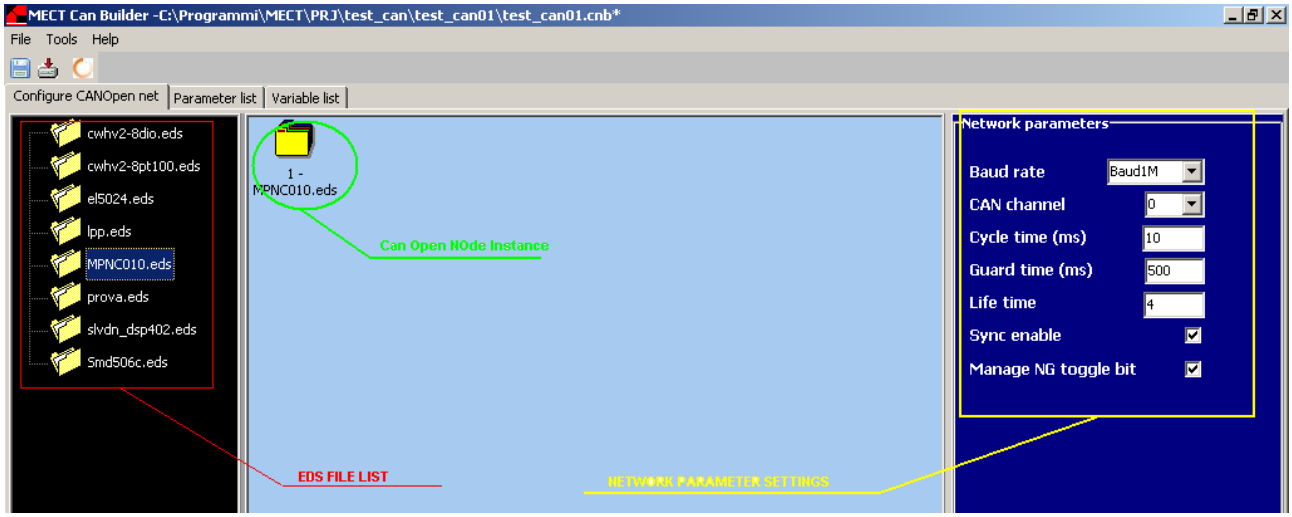


Click on the icon “New Project” and through the “Set Workspace” button select the project destination folder. Fill in the Project Name field with your project name and click on the “Create Project” button to complete the project creation and start the Can Builder software.



The CanBuilder main window is made by three sections:

- EDS file list
- CanOPEN Nodes instantiated in the network
- Network parameter settings



8.1 EDS File List

The left side of the Can Builder window showes the list of EDS file available to create a CanOPEN network.

8.2 Insert a node in the network

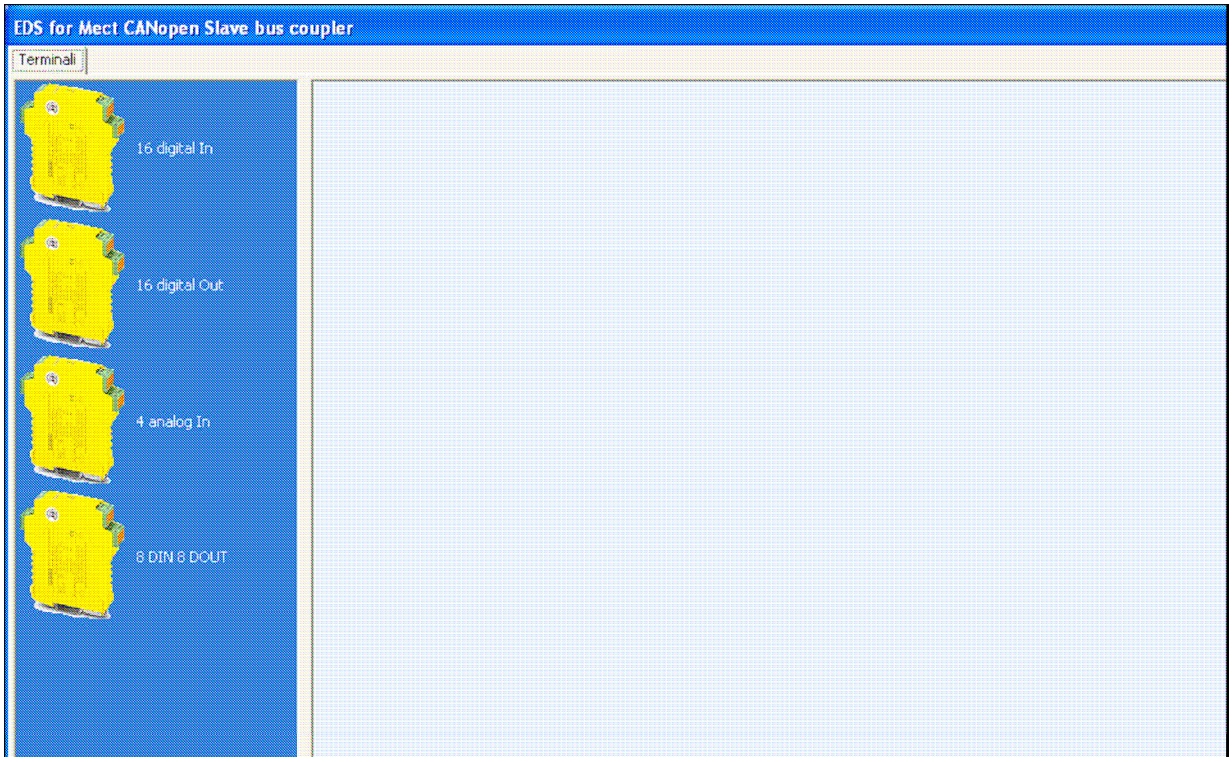
To add a node in the CanOPEN network select the EDS file that represents the node to be created. By double clicking on the chosen EDS file a new node will be instantiated in the network and will be visible in the central section of the Can Builder window. Also, an ID will be automatically assigned to the node; by default the ID will be the first still free.

8.3 Node Configuration

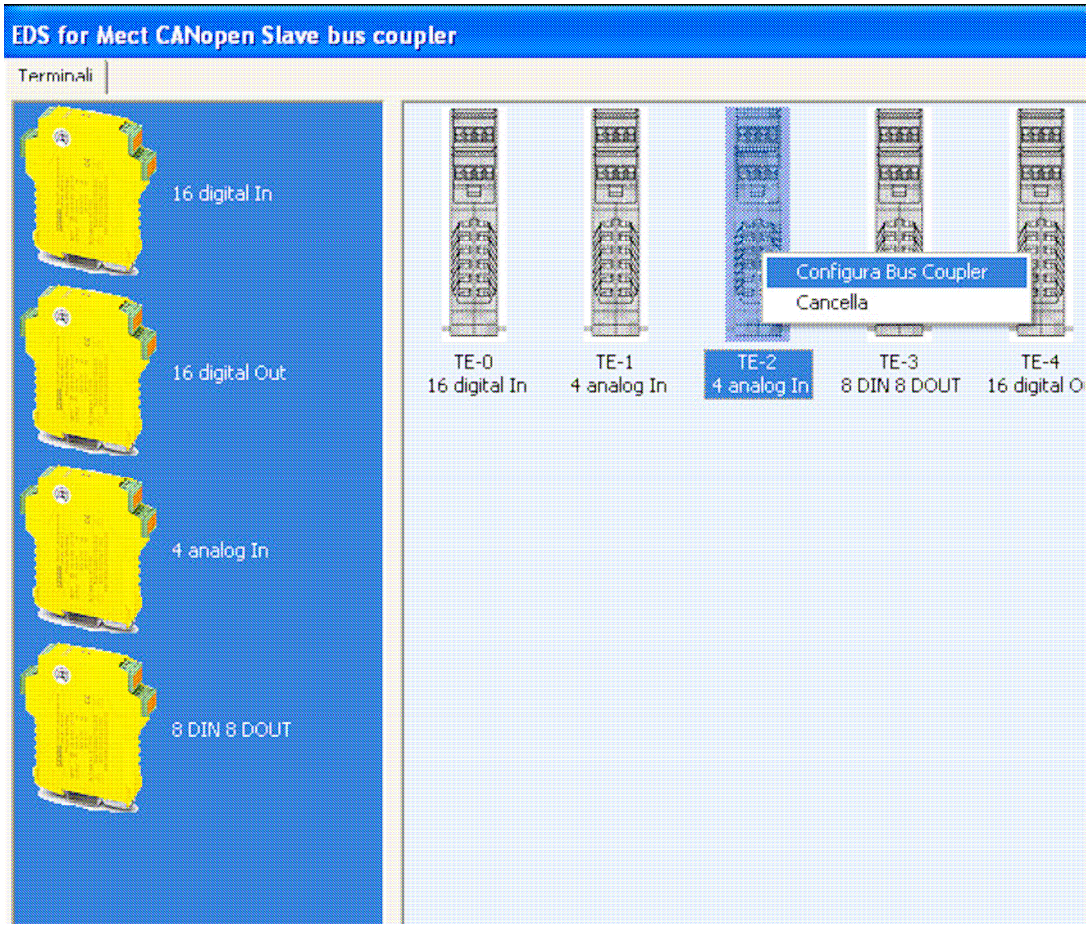
Once a node has been instantiated, the configuration file that contains variables and parameters value must be created to allow the communication with the CanOPEN master.
Even if the Can Builder software supports the configuration of a generic Node in case of MECT CanOPEN nodes the software allowes a graphical configuration that simplify this activity.
The following section describes the configuration of a MECT CanOPEN node, while the configuration of a generic one is depicted in section 8.3.2

8.3.1 MECT CanOPEN Node

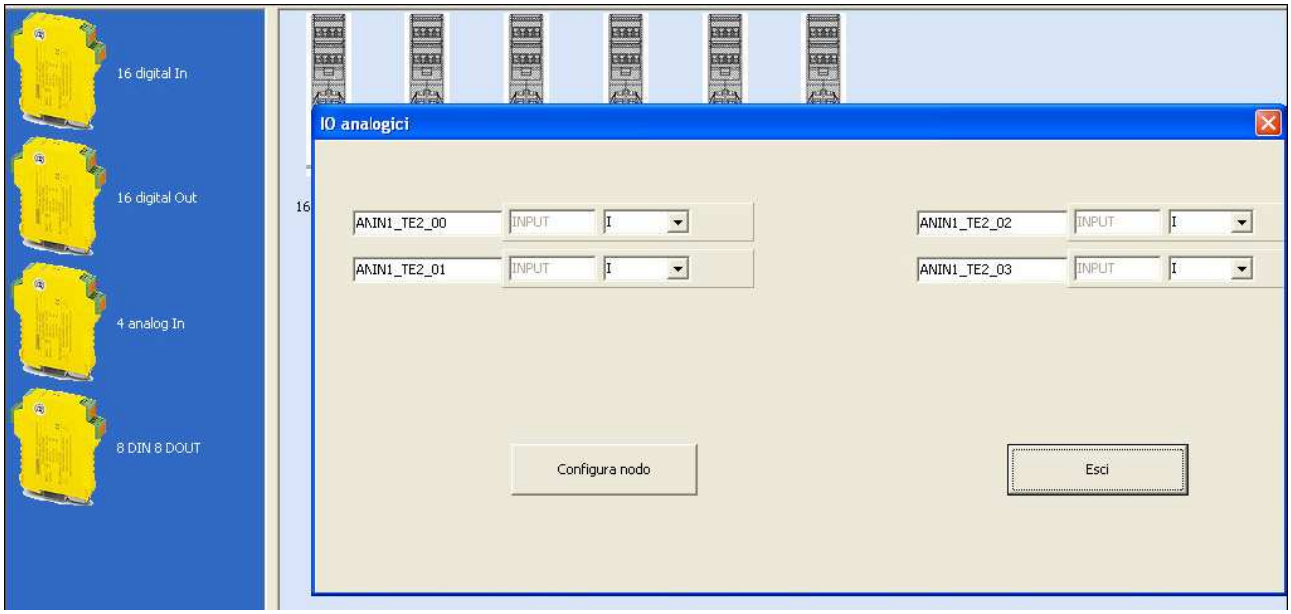
When building a CanOPEN network based on the MECT MPNC module, after instantiating the number of required nodes by double clicking on the instance to configure the following window appears:

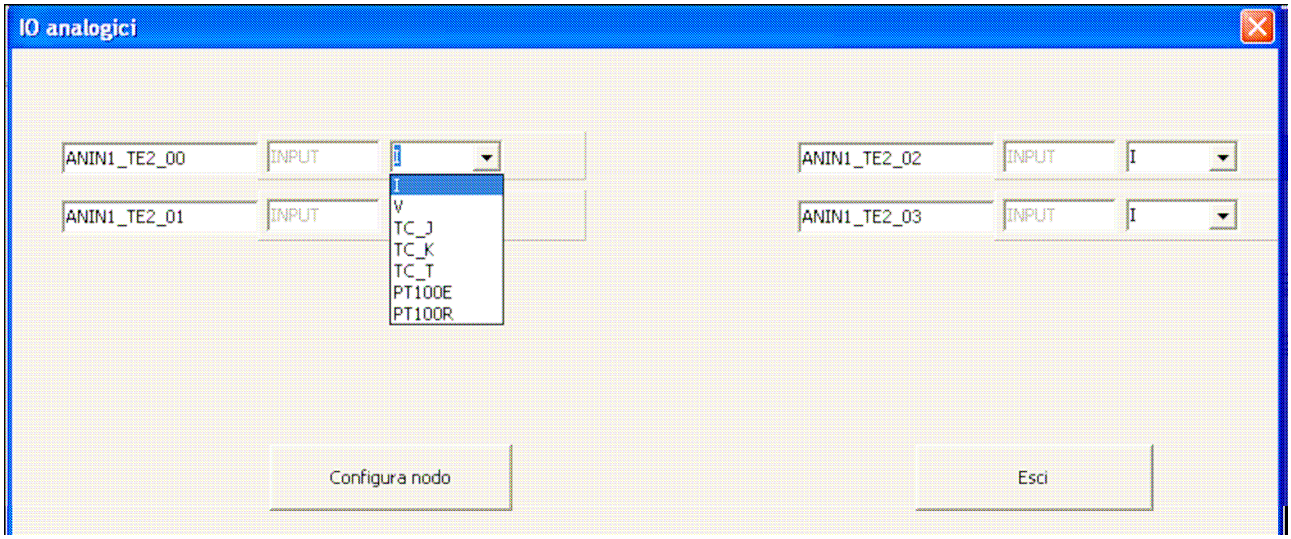


The configuration window offers two sections: the left one showes the various kind of MECT MPNC available terminal while the right one will contain the tarminal instances that will compose the node. To configure the node select the kind of terminal you wish to use and drag it on the right side of the configuration window. Each terminal will be automatically assigned with an identifier.
Pay attention, the sequence of instantiated terminal must be the same when phisically assembling the node.



Analog terminal channels can be configured one by one. Right click with the mouse on an analog terminal and select the Bus Coupler Setup option in the pop up that will appear.
The Bus Coupler Setup window showes all the channel available for the terminal. Each channel can be configured by selecting one of the available channel configuration option in the dropdown menu related to the channel itself.

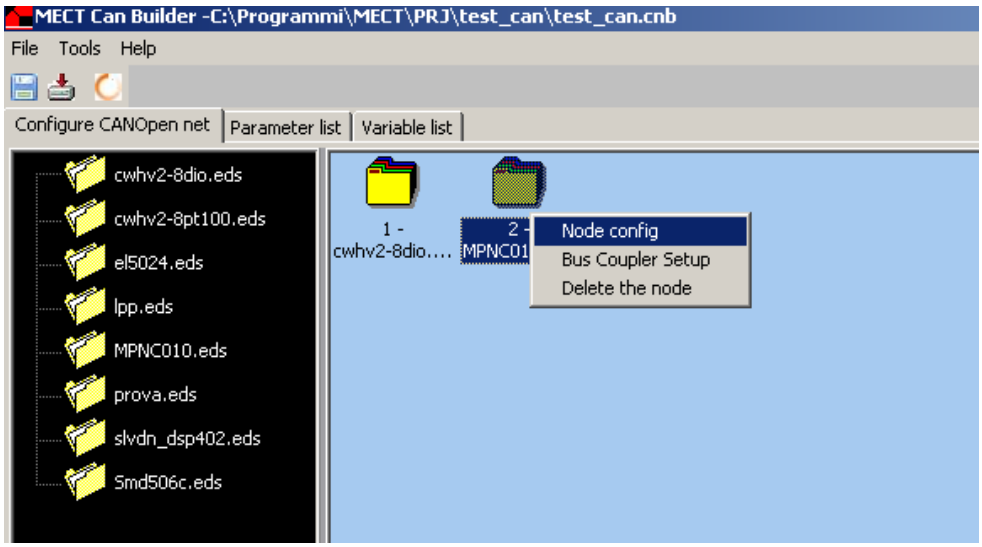




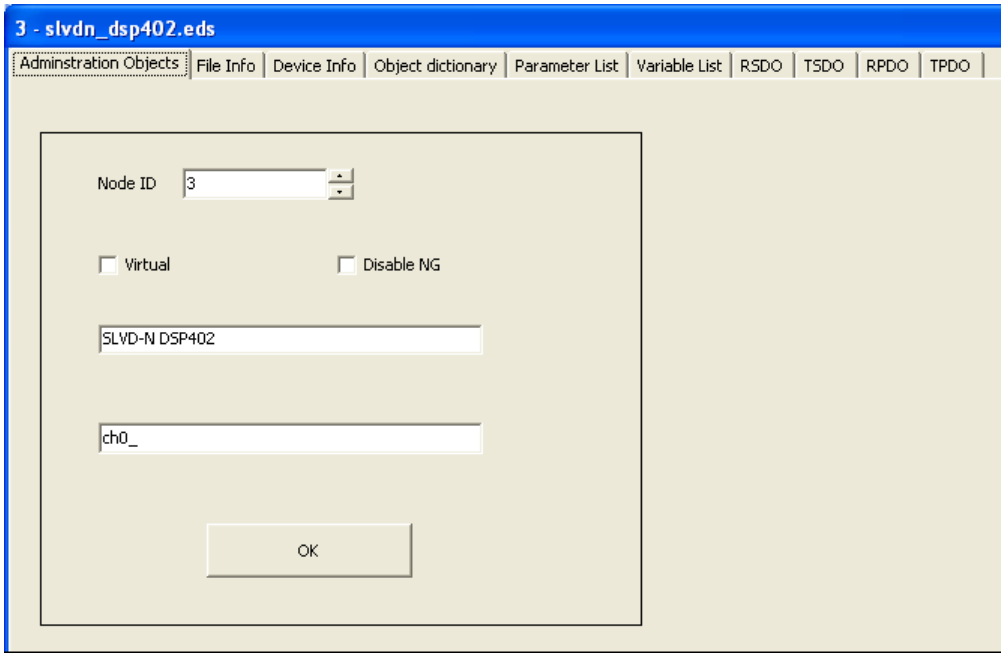
To save the chosen configuration press the “Node Config” button, while to matain the previous settings just press the Exit button. Once terminal configuration has been accomplished by closing the terminal configuration window you’ll be back in the main CanBuilder window where the Download Configuration File button allowes the transfer of the CanOPEN Network configuration to the TPAC CanOPEN Master as showed in section 8.6.1.2.

8.3.2 CanOPEN Node Manual Configuration

To configure a node, right click on the node instance as shown in the below picture and chose the Node Config option.



A new window, with 10 configuration tabs will appear. Those tabs are described in the following sections.



8.3.2.1 Administration Objects

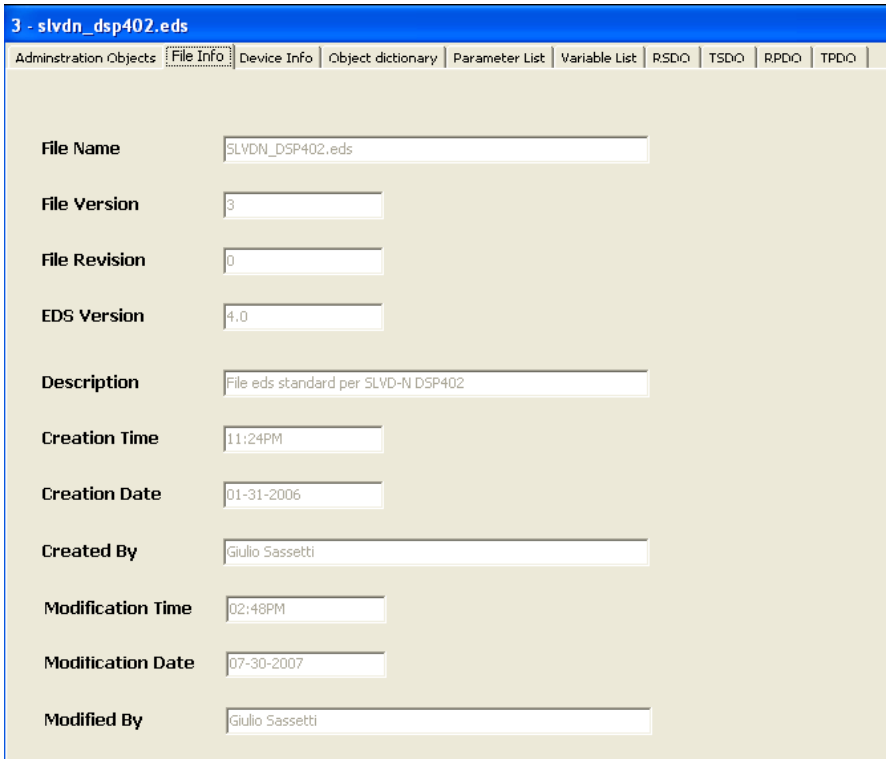
In this section you can set and visualize the value of the following parameter:

- The node ID eventually it can be modified here
- Node Guarding enabled/disabled state
- Node virtualization
- Node name as shown in the EDS file
- Prefix for network variables to be exported in the PLC

All modifications will be retained only if confirmed by pressing the OK button.

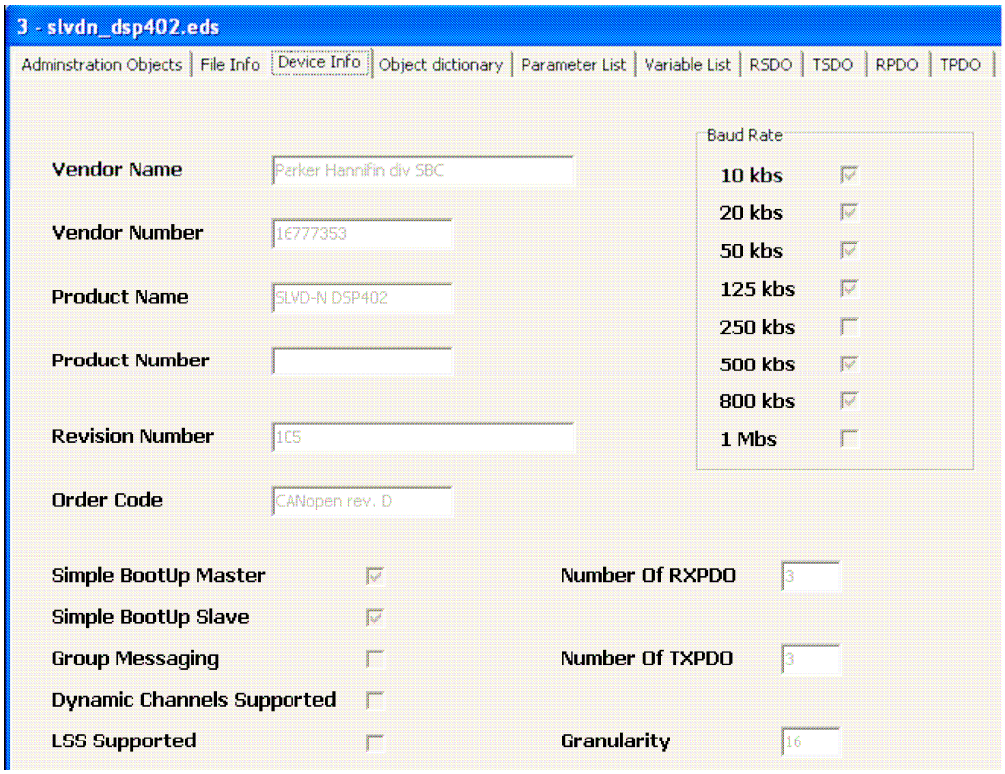
8.3.2.2 File Info

This section showes data contained in the EDS file related to the node. All shown data cannot be changed by the user.



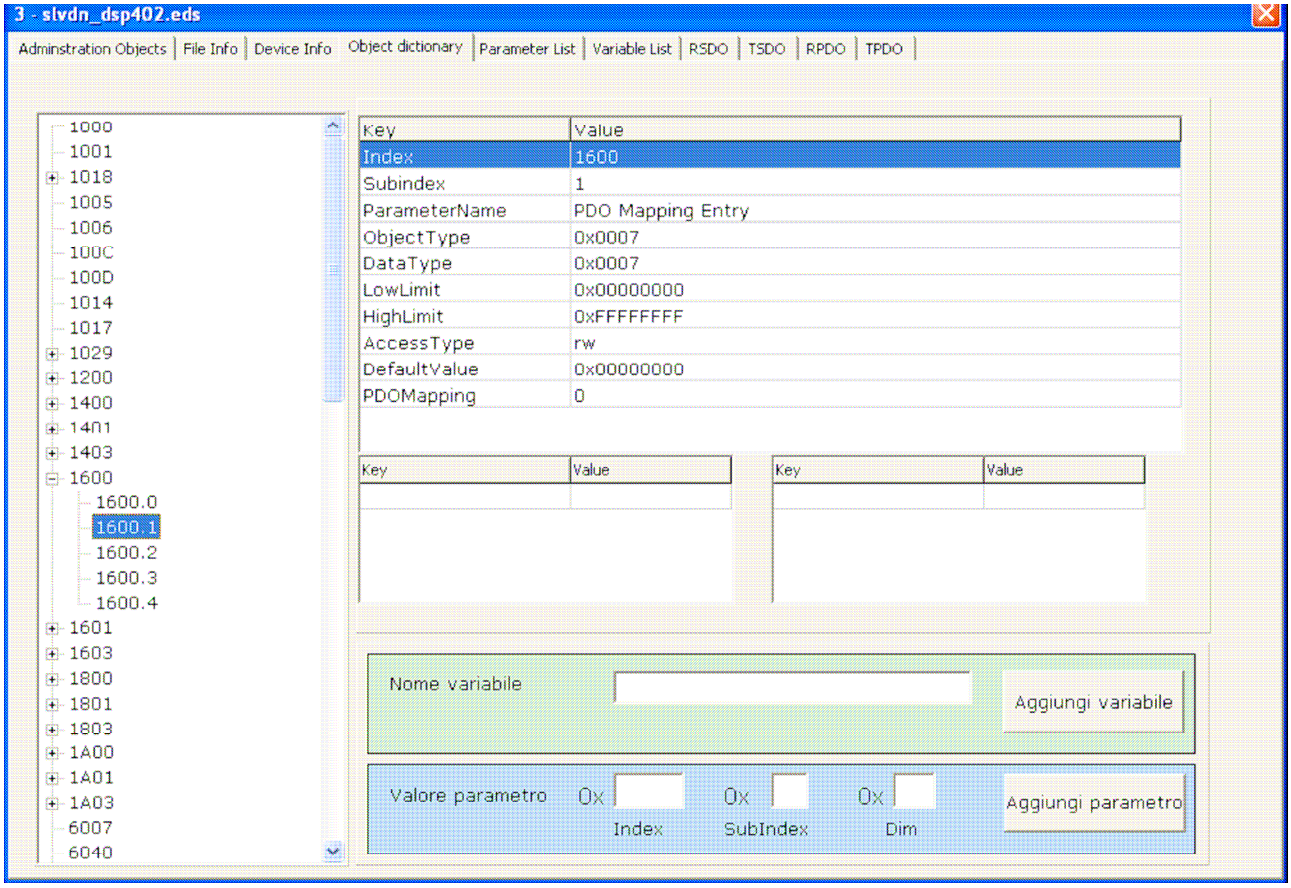
8.3.2.3 Device Info

The third section shows the data regarding the characteristics of the selected node, as the number of PDO, the baud rate available, etc.



8.3.2.4 Object Dictionary

In this section, that contains the list of the node dictionary object, the user can set node parameters and variables.



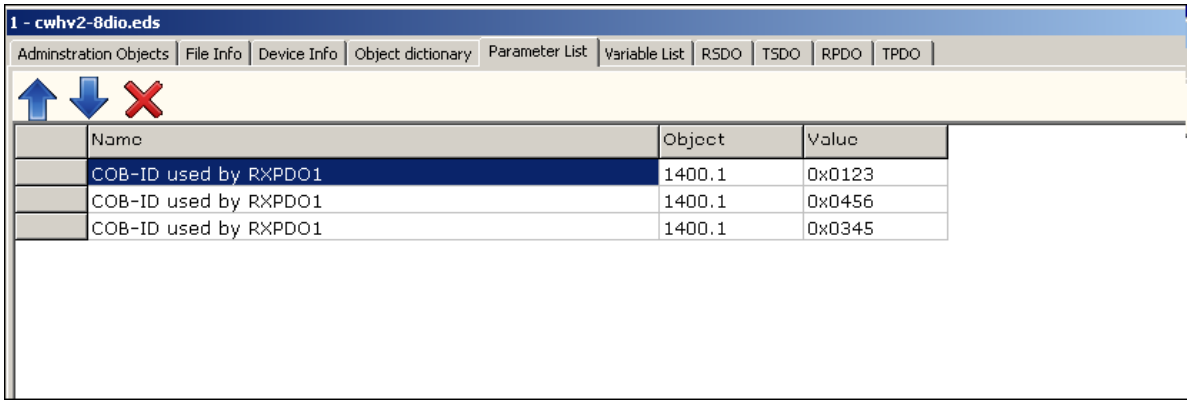
As can be seen from the figure, the window is divided into several sections, the left side contains the list of objects available in the node that need configuration. By selecting an object, its properties are shown in the top part of the window, its. For each object with write access (w) you can insert a parameter that will be sent by master in the configuration step in order to configure the node; besides you can associate to the object a variable to make the object accessible through the PLC. For some objects, such as those that enable PDO, you must enter more than one parameter which will be sent in sequence to the node by the master during the configuration. We will see later how to change the order used to send configuration parameters.
Read only (ro) object type can be bound only to a single a variable whose value can be read through the PLC.
To clear any parameters or variables select with the mouse the value to delete, right click on it and chose delete in the pop-up menu that will appear. Remind that items to change in this section are closely linked to the node and the application you wants to achieve.
In order to use the SDO service by PLC, the program Can Builder must assign a name to the dictionary object to which you need to access to.

8.3.2.5 Parameter List

The parameters set in the Object dictionary tab are collected in this section as shown below.

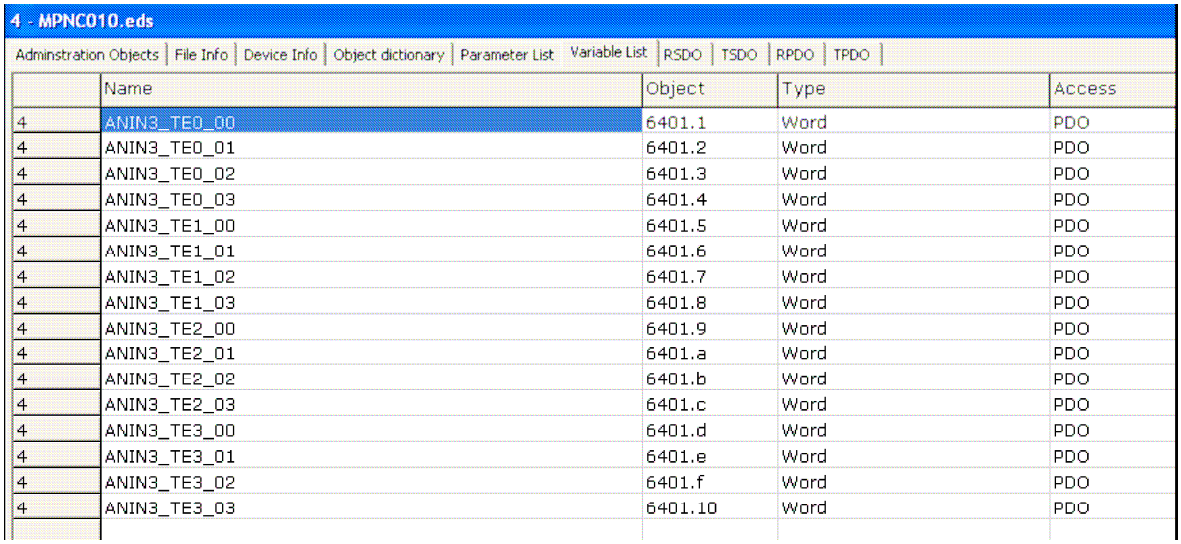
Theese parameters are sequentially sent by the master at the inizialization step. The Parameter list tab showes the order that will be used to send them. If necessary, you can rearrange the order of

configuration parameters by moving them in the Parameter list by selecting the item you want to move and using the up-down available arrows.



8.3.2.6 Variable List

The picture below lists the variables created in the Object Dictionary; those variables will be user-accessible via the PLC. The list of variables can not be changed.



8.3.2.7 SDO and PDO list

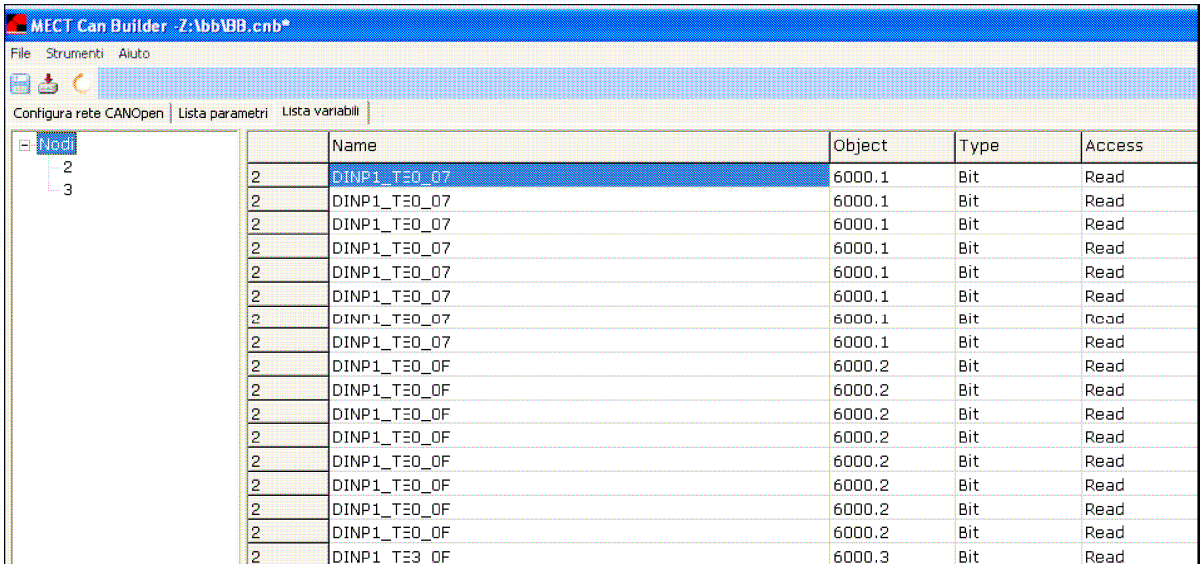
Sections RSDO, TSDO, RPDO, TPDO show respectively:

- SDO with read permission
- SDO with write permission
- PDO with read permission
- PDO with wirte permission

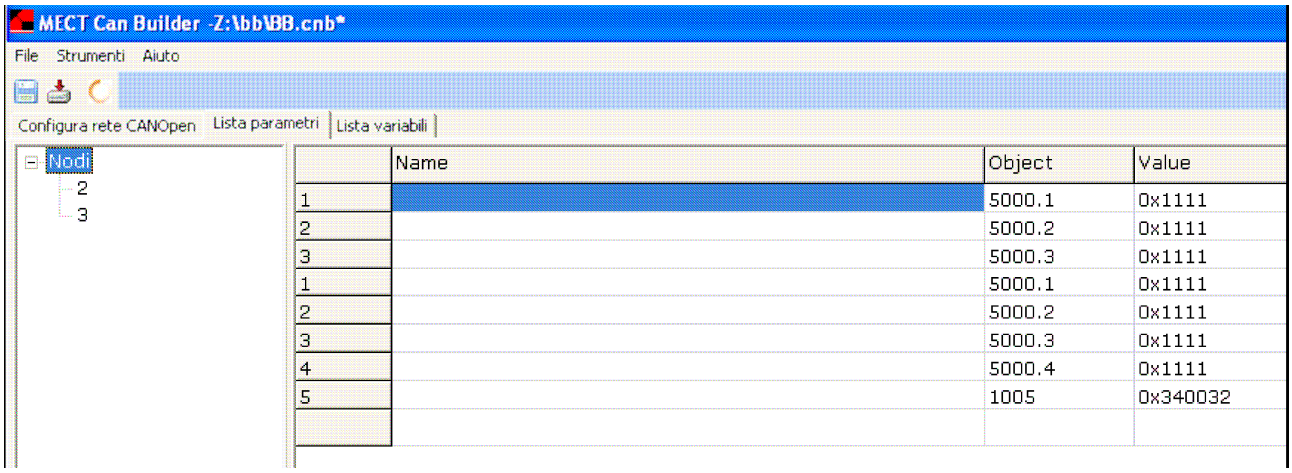
Theese lists are read only and contain a different representation of the object dictionary.

8.4 Object List

In previous sections we have seen that some objects have associated parameters or variables and we have seen how the lists of variables and parameters can be created. Going back to the Can Builder main window by selecting the tab “Variable list” the list of the variables associated to all the nodes that form your network will be displayed.


MECT Can Builder -Z:\bb\BB.cnb*
File Strumenti Aiuto
Configura rete CANOpen | Lista parametri | Lista variabili
Nodi
2
3
Name | Object | Type | Access
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_07 6000.1 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE0_0F 6000.2 Bit Read
2 DINP1_TE3_0F 6000.3 Bit Read

In the same way by selecting the tab “Parameters List” you can visualize the list of parameters that will be sent from the master to the nodes available in the network during the configuration step.



The previous mentioned lists summarize all variables andp arameters that will be used in your network configuration.

8.5 Network parameter configuration

The rightmost portion of Can Builder main window shows the parameters used to configure the CANopen network:

- *Baud rate:* speed of data transmission
- *CAN Channel*: which of the two TPAC CAN channels must be used
- *Cycle time:* of the CANopen network
- *Guard time:* time between two Node Guarding messages sent by the master
- *Life Time:* number of Guard time periods over which the master message is considered disconnected when a Node Guarding messagges is not received.
- *Sync Enable:* the master is required to send sync
- *Manage NG toggle bit:* the master is required to send NG message with data bit that will toggle each time.

The previous mentioned parameter will be sent ot the master during the configuration.

Once the network parameters have been modified to retain the new values save the CanOPEN project.

8.6 Main Menu

The main Can Builder menu is made by:

- File
- Tools
- Help

8.6.1 File Menu

The file menu allowes:

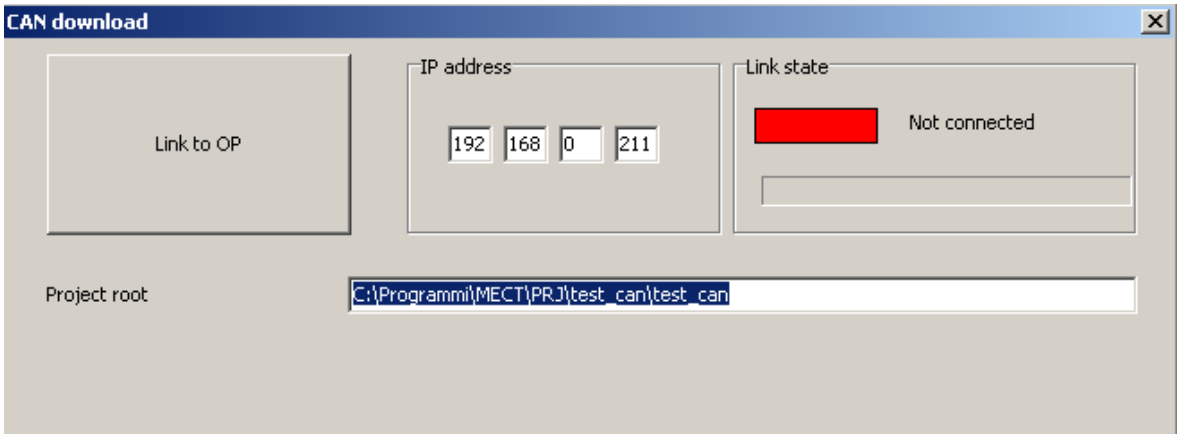
- build the configuration file
- download the configuration file
- save project
- exit

8.6.1.1 Build the configuration file

In the project folder this option creates the configuration file to be sent to the master.

8.6.1.2 Download the configuration file

Configuration file are downloaded to the TPAC by the LAN network connection. Chose “download configuration file” in the file menu. The following window will appear



Set the IP address for the TPAC master on your network and press the “Link to OP” button this will enable the transfer of your configuration file.

8.6.1.3 Project Save

Select “Save the Project” to save your project file in order to re-use your project later.

8.6.2 Tools Menu

The Tools Menu containns:

- Rearrange
- Import EDS

8.6.2.1 Rearrange

When nodes are repeatedly inserted and deleted from a network it can happen that nodes are no more sorted with with increasing ID. The rearrange button restores the correct sorting.

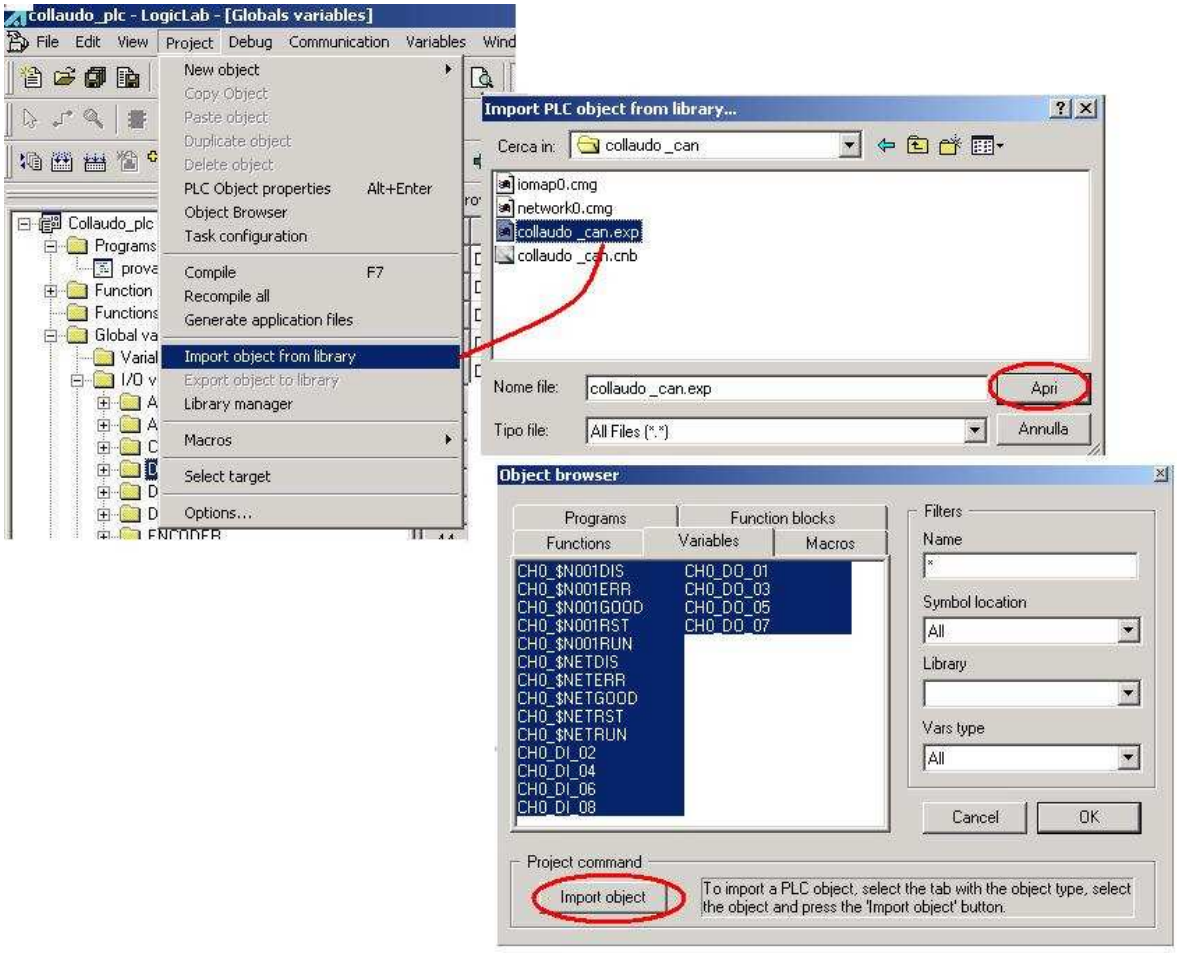
8.6.2.2 EDS Import

MECT Can Builder software allows the usage of any type of CANopen node with a MECT CanOPEN master. However, in order to use a node, the EDS file related to the node provided by the node manufcturer must be imported in the configuration tool. By chosing EDS Import on the menu Tools a dialog box that allows you to insert and manage a new type of node will be opened. Conversely, cancellation of an EDS file is done by selecting the file you want to delete form the EDS file list. Right click with the mouse on the selected file and chose from the pop-up menu that will appear the “Delete EDS” option.

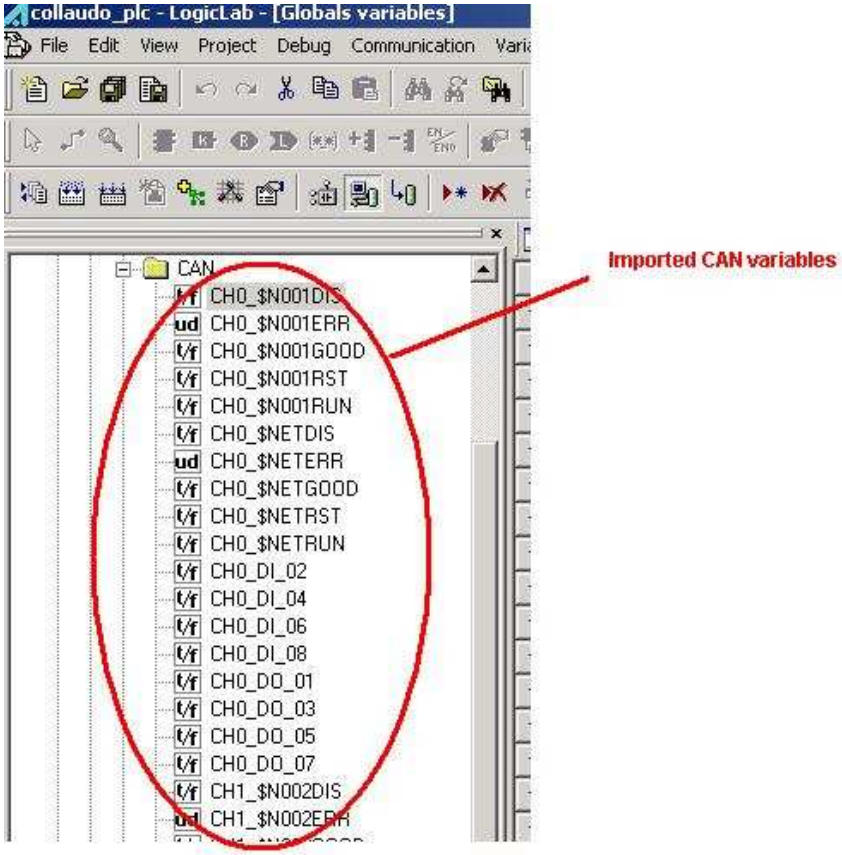
8.7 Using the CANopen objects in the PLC

8.7.1 Import Can variables in LogicLab

We must import the variables created with Can Builder to make the inserted node available, into our PLC project, and use them as any other PLC variables.
To import the CANOpen variables, from the **LogicLab** menu **Project** select **Import object from library.** In the opened pop up window, browse the file system until you reach the project directory created by Can Builder and open the **var.exp** file. Rember that variables file have .exp extension.



Select the **Variables** tab on the pop-up window **Object browser**. A list of CAN variables is presented, select all, and press the button **Import object**.
The selected variables will be inserted into the PLC project and become usable like any other variable.



8.7.2 SDO Usage

CANOpen protocol relates PDO to variables that need to be known in real time or need to be heavily modified during the PLC execution. On the contrary the protocol takes care of less frequently updated data such as node configuration parameters, usually modified only at the beginning of a new running cycle, through the SDO (Service Data Object).
The SDO is serviced by two functions SDORead and SDOWrite that allows node configuration. SDOs can access any parameter defined in the node object dictionary but they are not suited to make real time parameter modification since they require an acknowledgment and so are quite slow.
After naming all the objects that you need to access to, upload CanOPEN project on the TPAC target as described above. Once configured, the objects are read and written in the PLC program by invoking the SDORead SDOWrite and functions.
SDO Objects will be read and written in the PLC program by calling the **SDORead** and **SDOWrite** functions.

8.7.2.1 SDORead in a PLC program

The function res:=**SDORead**(0,'pr80') requires two parameters: the first specifies which of the available CANOpen network is indented to receive the request; the second one states the name given to the object through the **Can Builder** program.

The function returns an error code: 0 on success. Detailed explanation about error codes is available in the user manual. It worth to point out that for the **SDORead** function a 0 error code means only that the SDO service requesting a parameter has correctly been forwarded and accepted in the network.
Actually the addressee node will answer by its time schedule hence receiving the 0 code from a **SDORead** does not imply that the data is accessible. The data is stored in the **SDODATA** variable only when, after **SDORead** operation, the **SDOStatus** variable is set to a value different from 0.

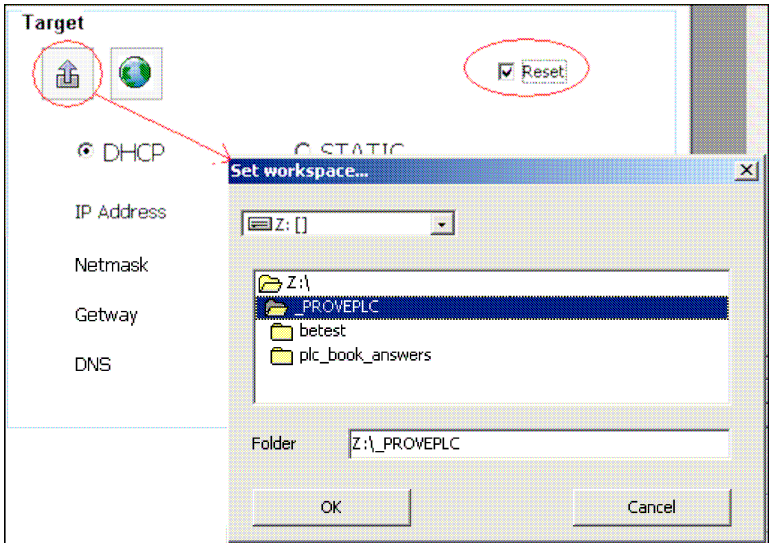
8.7.2.2 SDOWrite in a PLC program

Besides the network and the name of the object involved in the request, the **SDOWrite** function, requires, as additional parameter, the value to be written in the addressed CANOpen object.
The function returns an error code reporting a successful execution or a failure.
SDO services need an acknowledgement; the node receiving a write request, answers by sending a confirmation upon data receipt. Hence, in order to make consecutive writing, when the PLC program issues a **SDOWrite** it must wait until the **SDOStatus** variable goes to a value different from 0 before starting the next writing operation.

NOTE: To properly deal with **SDORead** and **SDOWrite** functions each object in the network needs to be identified univocally. Working with two identical nodes belonging to the same network and making access to the same object (i.e. object 2000.51) implies assigning to each object a unique name.

9.0 RESETTING THE SYSTEM

If you can no more obtain the control of TPAC (for programming or configuring it) there is a back door that make possible reset the TPAC. From the **Target section** of the dashboard, open a project or create a new one. Press the button **Settings**, the window will show the configuration parameters. Check the **Reset** label. Insert into a USB port of the PC the pen-drive, then press the button: **export current configuration**. The pen-drive will be loaded with a reset configuration.



Afterwards, plug the pen-drive into the USB port of the TPAC, then power it on. The code files of PLC, HMI and CANOpen will be erased from TPAC flash memory. The TPAC becomes free from code files that may be the cause of problems.

10.0 RECEIPTS

10.1 INTRODUCTION

TPAC has the ability to manage the receipts into a PLC program. When a HMI project is created the receipts software package is automatically loaded.
In this manual we'll describe both what the programmer and what the final user have to do to use the receipts in a PLC project.

10.1.1 Programmer side

When a PLC program wants to use the receipts the first step for a programmer, is to define the receipt needed variables and declare them into the retentive memory.
Once defined, the programmer have to link the variables to the receipt. This step take place in the HMI environment. When a new project is created, the global function: **Rcpt_add_vars** is available to the programmer.
Inside this procedure, two functions deal with adding variables: **Rcpt_add_tyReal_par** to add a float variable and **Rcpt_add_tyDInt_par** to add a signed integer variable.

The above mentioned functions require four parameters:

- The list position of variable: integer from 0 to N.
- The name of PLC variable to be associated, as defined into the PLC project.
- The mnemonic associated to the variable that may be either the variable name or the any other name. The maximum string length is 18 characters.
- The measurement unit associated to the variable. The maximum string length is 5 characters.

The function return zero if the operation is correctly handled.

For instance to insert the PLC variable Var1, in the first position of a receipt, defined as real variable, with mnemonic "speed" and measure unit "m/s". The result is stored into the Result variable.

```
Result:=Rcpt_add_tyReal_par(0,Var1,'speed','m/s');
```

To use receipt values into a PLC program the selected receipt parameters need to be copied into the PLC. The programmer must predispose this copy, by inserting into the procedure **Rcpt_store_vars**, the functions that assign the value of each element to the corresponding PLC variable. The functions to be called are: **Rcpt_get_tyDInt_par(j)** to copy the element j of the receipt in a signed integer variable, and **Rcpt_get_tyReal_par(j)**, to copy the element j into a real variable.
The **Rcpt_store_vars** procedure is called when the user press the **Store** button.

Note: The PLC variables that belong to the receipt must be placed into the retentive memory block. In this way, the variables values will not be lost when the TPAC is turned off.

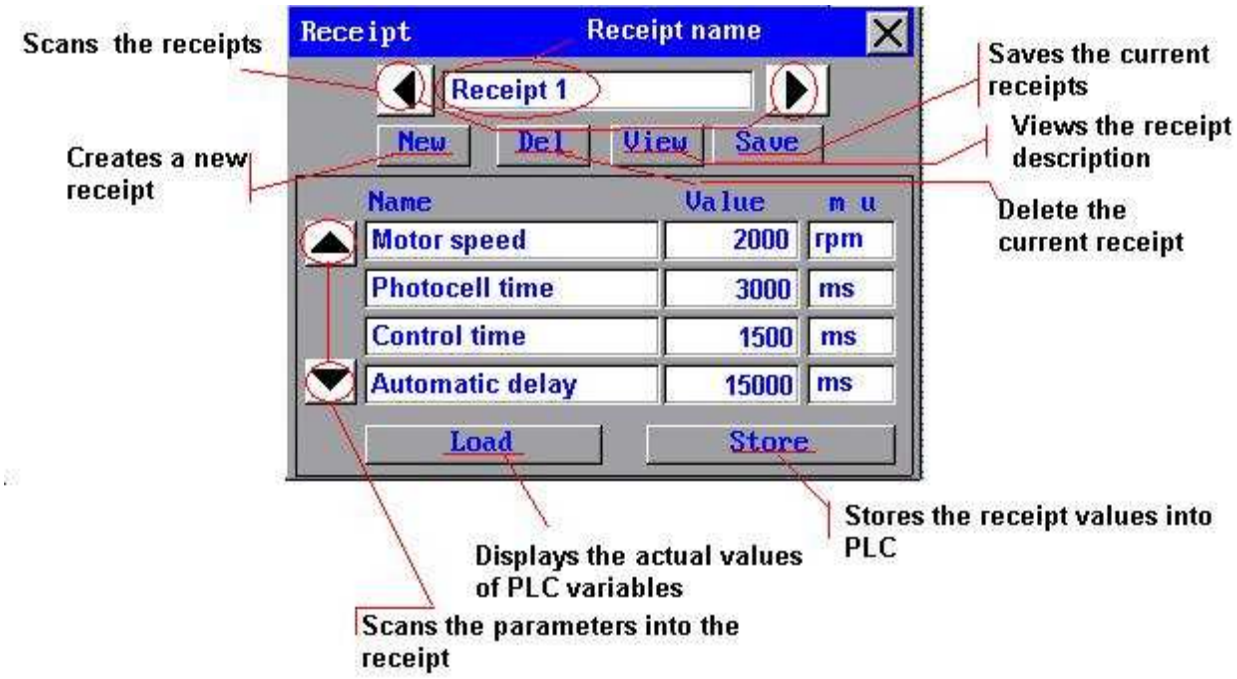
To call the receipt package main window, the programmer needs to open the window "**ric**".

10.1.2 Final User side

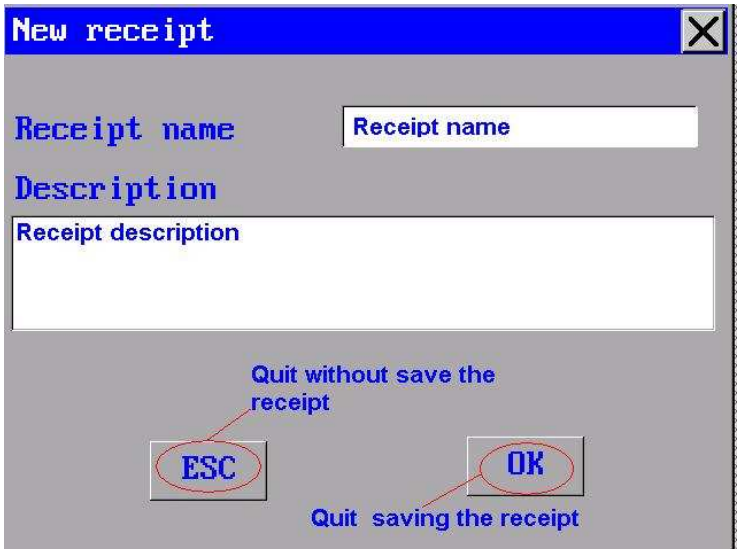
A graphical interface is made available for the final user in order to:

- Insert new receipts.
- See the receipts parameters.
- Delete receipts.

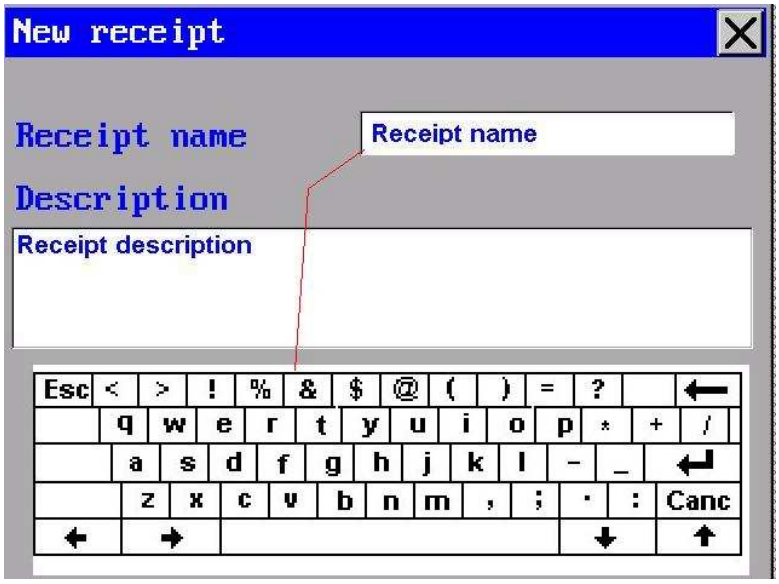
- Scan the receipts list.
- See and modify receipts descriptions.
- See and modify the values of PLC variables part of a receipt



To create a new receipt
Pressing the button **New**, shows the **New receipt** window. In this window the user must insert the name of receipt and, if needed, its description.



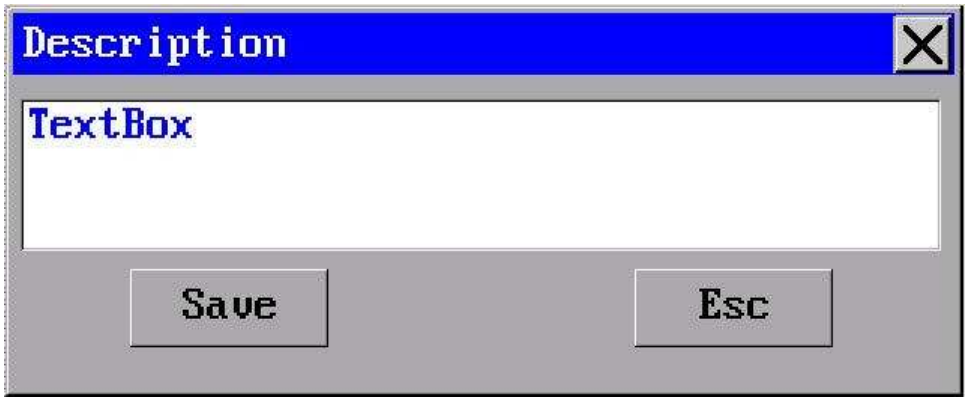
To insert the name of the receipt the user must touch the field **Receipt name.** A virtual keyboard appears on the screen. Receipt names are limited to maximum18 characters. To confirm the insertion, press ↵ on the virtual keyboard or **enter** on the hardware one.



The field receipt description is an explanation associated to the receipt that helps the user to better identify it. Touching the field **Description** displays the virtual keyboard. At most 190 characters may be contained into the description field. To end the description typing, press the **Esc** button on the virtual keyboard.
By pressing **OK,** the receipt with its name and description is saved.
The parameters values of the new receipt are loaded from actual PLC variables.
If **ESC** is chosen the **New receipt** page is closed and no receipt is created.

Delete a receipt
To delete a receipt from the list, after selecting it, press **Canc**, a dialog window will ask to confirm the deletion. If **Yes** is chosen, the receipt will be definitely lost.

Visualization and description change
The description associated to a receipt is shown by pressing the button **View** in the page **Receipt.**



When the description window is shown, to modify the text, press on the text box field and the virtual keyboard will be available. To exit while saving the modification, press **Save**, otherwise press **Esc** to discard any changes.

Modify the value of receipt parameters
If you have a newly created receipt or you selected an old one, four parameters are visible on the screen. To view all the other parameters associated with the chosen receipt just press the arrows buttons placed on the left part of parameters fields. Each parameter has three attributes: **Variable**

Name, **Value** and **m u** (measurement unit). The **Variable name** and **m u**, are fixed (defined by the programmer) and can't be modified by the user; the field **Value** instead, may be changed by the user. If any changing is required the user may save it through the button **Save** in the **Receipt** page.

Saving the receipt parameters into the PLC variables
The receipts are saved on the TPAC flash memory. To save receipt's parameters into the PLC program, the user must select the needed receipt through the receipts scan buttons and then press the **Store** button. The parameters values of the receipt are inserted into the PLC variables and immediately used by the program.

Visualization of actual PLC variables
The **Load** button, allows the user to see the receipts actual values of PLC variables.

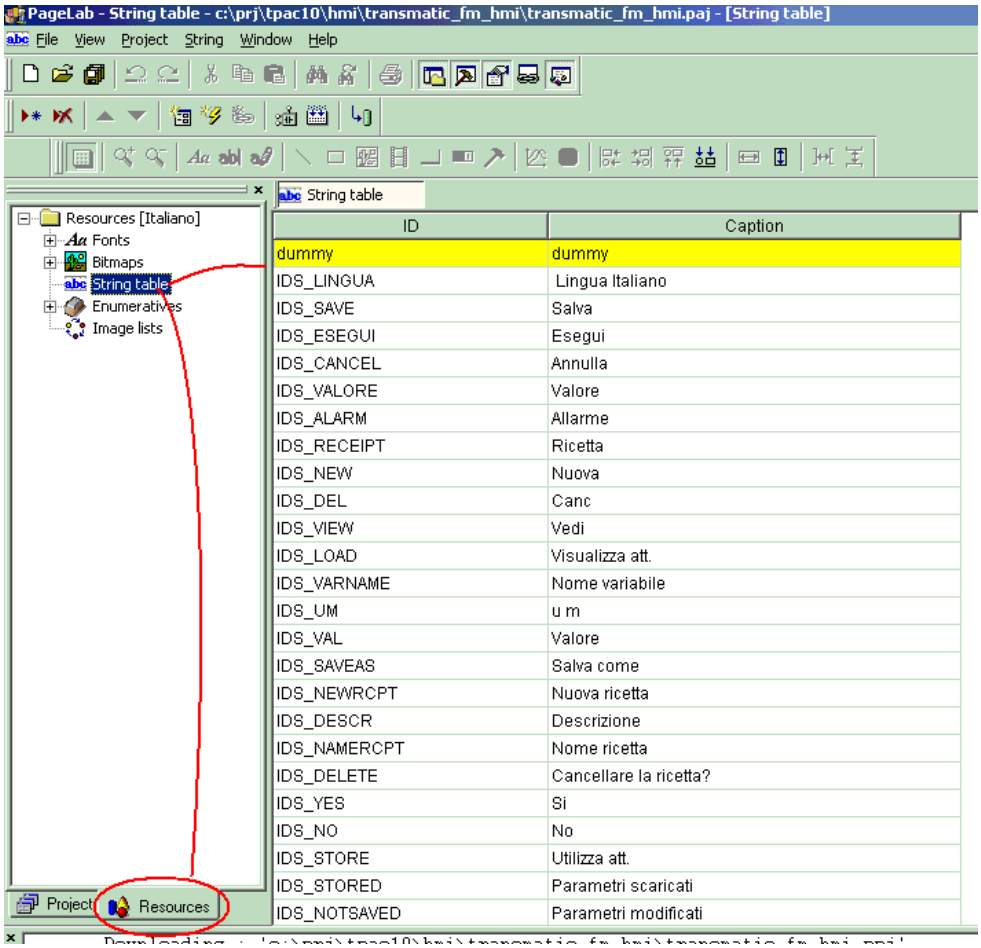
11.0 LANGUAGE MANAGEMENT IN HMI ENVIRONMENT

11.1 INTRODUCTION

When inserting a string in a **PageLab** project, is always possible to write the plain text, or use a resources string, by calling its identifier. In the first case the text will be always constant, while, by using the resources string the text will be displayed in the active language.

11.2 STRING TABLE

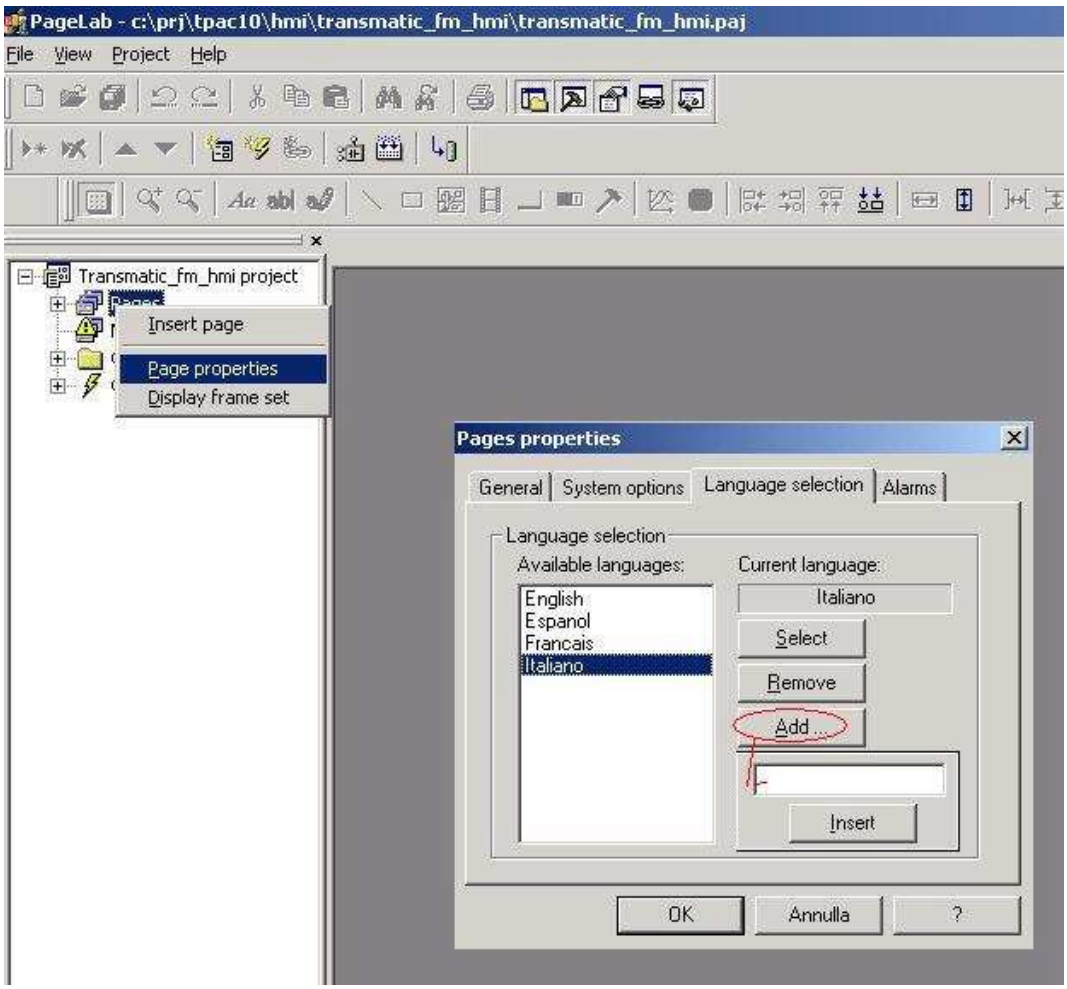
To show the string table, press the Tag **Resouces** in the project window, then select the key: **String table**. The table is composed by two columns, the left column contains an identifier (**ID**), the right one the string that will be shown on screen (**Caption**).



To add a string to the table press the button in the tool bar, a new row will be added. Select the **ID** cell, and insert the identifier name, then select the cell **Caption** and insert the string to be associated.

11.3 INSERTING A NEW LANGUAGE

From the project window select **Pages** and then **Page properties** to view the window Pages properties. Select the Tab **Language selection;** the available languages field shows the list of languages defined until now. To add a new language press the button **Add…**, insert the name of the language, then press **Insert:** the new language is added to the list.



To set the new current language in the **PageLab** environment highlight a language in the Available languages list and press the button **Select**. When pressing **OK** the **Page properties** window will be closed and all changes saved.
Once selected the language, the programmer must modify the strings table by inserting the string translations. Open the strings table as described in the previous section, and modify the values in the **Caption** column.
NOTE: The just described language selection does not modify the language shown on the TPAC, it is only used by programmer to fill the strings tables in **PageLab** environment.

11.4 MODIFY TPAC LANGUAGE

Modifying the variable **sysLangID** changes the language displayed by TPAC screen. Values assignable to this variable are defined by constants. For example if there are 3 languages defined in

Pagelab: ITA, and ENG FRA, the compiler will create three constants: **kLangITA**; **kLangENG**; **kLangFRA**. To change the displayed languages assign one of the constant variables to **sysLangID** and then restart the TPAC.

To change the language without having to reboot the system you need to modify the global function **chg_lang ()** within the HMI program.

For each language created inside PageLab two other constants are generated. These constants are made by a suffix that represents the name of the created language (eg ITA, ENG, FRA, etc.) and a prefix: **kbLangIdx** for elements defined in the strings table and **kbEnumIdx** for enumerative strings. With respect to the above-mentioned example the following constants will be creted: **kLangIdxITA**, **kLangIdxFRA**, **kLangIdxENG** and **kbEnumIdxITA**, **kbEnumIdxENG** and **kbEnumIdxFRA**.

The function chg_lang () will be amended as follows:

CASE sysLangID OF

```
   kLangITA: dummy:=Video_LoadLanguage(?kbResStrings[kbLangIdxITA],
?kbResEnums[kbEnumIdxITA] );

   kLangENG: dummy := Video_LoadLanguage( ?kbResStrings[kbLangIdxESP],
?kbResEnums[kbEnumIdxESP] );

   kLangFRA: dummy :=Video_LoadLanguage( ?kbResStrings[kbLangIdxFRA],
?kbResEnums[kbEnumIdxFRA] );

END_CASE;

x1 := 1 ;
y1 := 1 ;
x2 := 318 ;
y2 := 238 ;
bStatRedrw := TRUE ;
bMapsReset := TRUE ;
EXIT ;
```

The lines to be included within the CASE construct are as many as the languages t to be managed. This procedure must be called whenever a change occurs in the* sysLangID *variable.

12.0 SOFT KEYBOARD

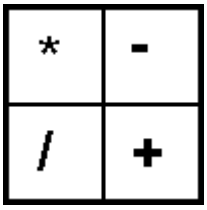
By default on the TPAC front panel there is a numeric keyboard, but in case of receipts for which some alphanumeric edit boxes fields exists, the numeric keyboard is not enough. In this case when the user touch the edit box field a virtual keyboard with alphabetic keys is available.

The default keyboard layout looks like the following:

The programmer may define by himself a keyboard with different layout and functions.

To define a new keyboard, the programmer must create an image of the keyboard he wants to create in gif standard.

For example, suppose that we need to create a four keys keyboard, with these keys: +-*/. Through a graphic editor create the following image:



The keyboard image must be less than 320 x 240 pixels, otherwise it can't be correctly shown on the screen. Also the file must be named **skbd.gif**.

Besides the keyboard image, the programmer needs to create a description file that contains its functionalities.

On the first row of the description the file contains the keyboard image dimensions (in pixels). From the second row and on, for each key there's a line with the following information:

- Key ASCII code
- Top left corner x coordinate
- Top left corner y coordinate
- Bottom right x coordinate
- Bottom right y coordinate

The description file must be named **skbd.txt**.

In example case the skbd.txt file will be:

```
100 100
42      3     3     48    48
45      51    3     96    48
47      3     51    48    96
43      51    51    96    96
```

These files, once created needs be saved onto TPAC, as described in the section **Update software**

13.0 COLOR DEFINITION HMI

TPAC uses a 256 color palette, coded in RGB standard, with an eight bit code for each color. By default in PageLab 16 colors are defined whose codes reported in the following table.

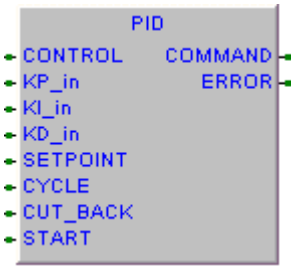
ID	hexadecimal RGB code
0.	000000
1.	000080
2.	008000
3.	800000
4.	008080
5.	800080
6.	808000
7.	808080
8.	AAAAAA
9.	0000FF
10.	00FF00
11.	FF0000
12.	00FFFF
13.	FF00FF
14.	FFFF00
15.	FFFFFF

When further colors are needed the programmer can add the new color in the file **C:\Programmi\MECT\TPAC_01\dashboard\MECTjar\TemplateHMI\Targets\TPAC.def**, the new colors that you wish to add.

NOTE: The colors number must always be a power of 2.

14.0 FUNCTION BLOCKS

PID



Parmeter	Data Type	Data Width	Description
CONTROL	REAL	32	Quantity under measurement
KP_in	REAL	32	Proportional Constant
KI_in	REAL	32	Integrative Constant
KD_in	REAL	32	Derivative Constant
SETPOINT	REAL	32	Setpoint
CYCLE	UDINT	32	PID Time Cycle in ms
CUT_BACK	REAL	32	Cutback Constant
START	BOOL	8	Start Regulating Command
COMMAND	REAL	32	Regulating value (-100% , +100%)
ERROR	BOOL	8	Reports that some parameters are not set properly

Description of PID Regulation.

When START goes to 1, the function block performs PID adjustment depending on the chosen parameters. The output regulator takes values ranging from -100% to +100%. When the time cycle or the constant proportional KP_in is set to 0, the function block raises the exit ERROR and no regulation is performed.

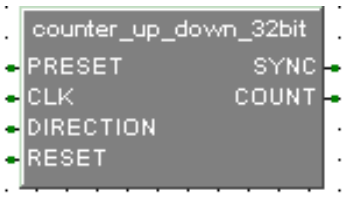
Self tuning PID

Parameter	Data type	Data Width	Description
CONTROL	REAL	32	Qunatity under measurement
START	BOOL	8	Selftuning Start Command
SETPOINT	REAL	32	Setpoint
KP_out	REAL	32	Calculated Proportional Constant
KI_out	REAL	32	Calculated Integrative Constant
KD_out	REAL	32	Calculated Derivative Constant
COMMAND	REAL	32	Regulating value (-100% a +100%)
TUNED	BOOL	8	Indicates when self tuning is complete
CUT_BACK	REAL	32	Calculated CutBack Constant

Description of PID self-tuning

When START goes to 1, the function block begins the self-tuning procedure using the parameters set. The COMMNAD output varies according to the chosen tuning algorithm. Once the self-tuning is completed the output TUNED is raised and outputs KP_out, KI_out, KD_out and CUT_BACK exhibit the calculated values.

32 bit up – down counter

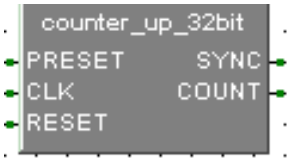


Parameter	Data Type	Dimension	Description
PRESET	UDINT	32	Counter value set from 0 to 2^32
CLK	BOOL	1	Clock input
DIRECTION	BOOL	1	DIRECTION = 1 count up DIRECTION = 0 count down
RESET	BOOL	1	If RESET = 0 the count set to zero, if DIRECTION = 1 (count up) Counter set to PRESET if DIRECTION = 0 (count down) SYNC set to 1
SYNC	BOOL	1	Terminal count Output. It stays to 1 if, in count up, it has the PRESET value, or in count down if it has 0
COUNT	UDINT	32	Counter current value

Description
32 bit up- down counter
The counter changes value if on the CLK input a rising edge is detected

If DIRECTION = 1 the counter is incremented by 1, if DIRECTION = 0 the counter value is decremented by 1.
If DIRECTION = 1, when the counter equals the PRESET value, the output SYNC is set to 1.
If DIRECTION = 0, when the counter equals the 0, the output SYNC is set to 1.
At the next rising edge on the CLK input, if DIRECTION = 1, the counter restarts from 0, if DIRECTION = 0 the counter restarts from PRESET value.
If RESET = 0 the counter sets the value to 0 if DIRECTION = 1, set to PRESET, if DIRECTON = 0.
If RESET = 0 the counter never changes its value

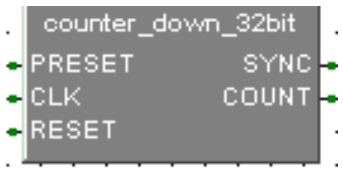
32 bit up counter



Parameter	Data Type	Dimension	Description
PRESET	UDINT	32	Counter value set from 0 to 2^32
CLK	BOOL	1	Clock input
RESET	BOOL	1	If RESET = 0 the count set to zero, SYNC set to 1
SYNC	BOOL	1	Terminal count Output. It stays to 1 if, in count up, it has the PRESET value.
COUNT	UDINT	32	Counter current value

Description
32 bit up- counter The counter changes value if on the CLK input a rising edge is detected When the counter equals the PRESET value, the output SYNC is set to 1. At the next rising edge on the CLK input, the counter restarts from 0, If RESET = 0 the counter sets the value to 0 If RESET = 0 the counter never changes its value

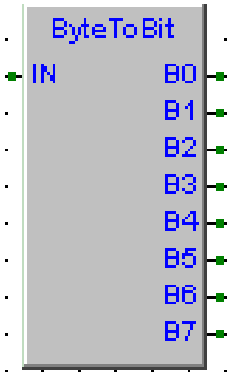
32 bit down counter



Parameter	Data Type	Dimension	Description
PRESET	UDINT	32	Counter value set from 0 to 2^32
CLK	BOOL	1	Clock input
RESET	BOOL	1	Counter set to PRESET SYNC set to 1
SYNC	BOOL	1	Terminal count Output. Set to 1 if counter value is 0
COUNT	UDINT	32	Counter current value

Description
32 bit down counter The counter changes value if on the CLK input a rising edge is detected When the counter equals the 0 value, the output SYNC is set to 1. At the next rising edge on the CLK input, the counter restarts from PRESET, If RESET = 0 the counter sets the value to PRESET If RESET = 0 the counter never changes its value

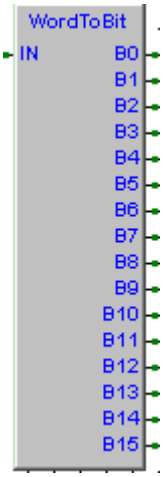
Byte to bit



Parameter	Data Type	Dimension	Description
IN	BYTE	8	Input Byte
B0..B7	BOOL	1	Output Bits

Description
Split the input byte in eight bits

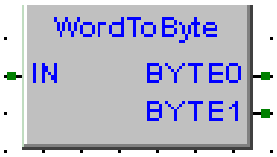
Word to bit



Parameter	Data Type	Dimension	Description
IN	WORD	16	Input word
B0..B15	BOOL	1	Output Bits

Description Splits the input word in 16 bits

Word to byte



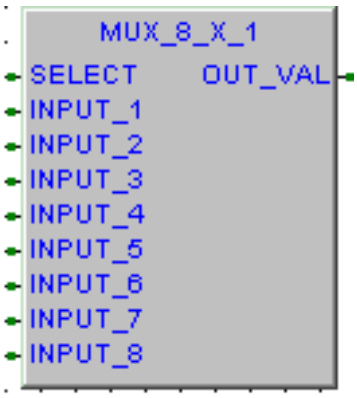
Parameter	Data Type	Dimension	Description
IN	WORD	16	Input word
BYTE0	BYTE	8	Output Byte low
BYTE1	BYTE	8	Output Byte high

Description Splits the input word in two bytes

Double word to byte

Parameter	Data Type	Dimension	Description
IN	UDINT	32	Input Double word
BYTE0	BYTE	8	Output byte 0
BYTE1	BYTE	8	Output byte 1
BYTE2	BYTE	8	Output byte 2
BYTE3	BYTE	8	Output byte 3
Description Splits the input double word in four bytes			

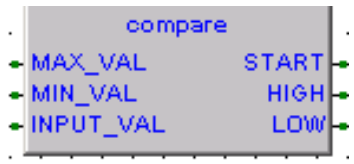
MUX_8_x_1 multiplexer 8 per 1



Parameter	Data Type	Dimension	Description
INPUT_1.. INPUT_8	BOOL	1	Input Bits
SELECT	USINT	8	Select which input bit is sent to the output
OUT_VAL	BOOL	1	Output bit

Description
OUT_VAL output is the input bit selected by SELECT input.

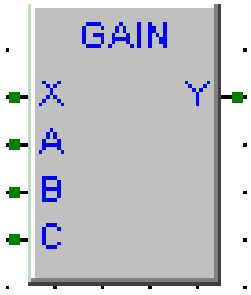
COMPARE



Parameter	Data Type	Dimension	Description
MAX_VAL	UDINT	32	Max limit value
MIN_VAL	UDINT	32	Min limit value
INPUT_VAL	UDINT	32	Input value
START	BOOL	1	Output: set to 1 if the input value is into the range limits
HIGH	BOOL	1	Output: set to 1 if input value is greater then max limit value
LOW	BOOL	1	Output: set to 1 if input value is smaller then min limit value

Description
ON-OFF control
If the 32 bit input value is into the range set by MAX_VAL and MIN_VAL limits, the output START is set to 1.
If the input is greater than MAX_VAL output START is reset, the output HIGH is set to 1; if input is smaller then MIN_VAL, the output START is reset, the output LOW is set to 1.

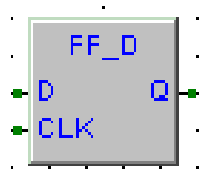
GAIN



Parameter	Data Type	Dimension	Description
X	UDINT	32	input X
A	UDINT	32	Multiplier parameter
B	UDINT	32	Divisor parameter
C	UDINT	32	Offset
Y	UDINT	32	Output Y

Description
Calculates the function value Y=X*(A/B)+C

FF_D: D flip-flop



Parameter	Data Type	Dimension	Description
D	BOOL	1	Input Bit
CLK	BOOL	1	Clock input
Q	BOOL	1	Output bit

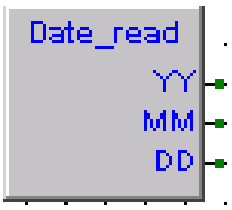
Description
The output Q, is equal to the input D when a rising edge is detected on the CLK input.

FF_T: T flip flop

Parameter	Data Type	Dimension	Description
CLK	BOOL	1	Clock input
T	BOOL	1	Output bit

Description
The output T toggles its value at every rising edge on the CLK input

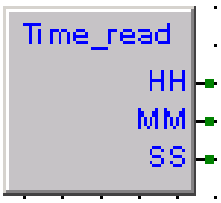
Date_ Read: read the current date



Parameter	Data Type	Dimension	Description
YY	UINT	8	Year
MM	UINT	8	Month
DD	UINT	8	Day

Description
Call this function to update the system variables DATA_YY DATA_MM DATA_DD

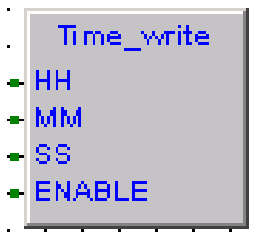
Time_ read: read the current time



Parameter	Data Type	Dimension	Description
HH	UINT	8	hours
MM	UINT	8	minutes
SS	UINT	8	seconds

Description
Call this function to update the system variables TIME_HH TIME_MM TIME_SS

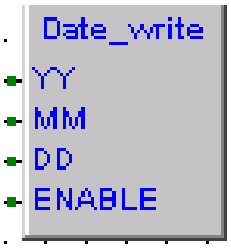
TimeE_write: write the current time



Parameter	Data Type	Dimension	Description
HH	UINT	8	hour
MM	UINT	8	Minutes
SS	UINT	8	Seconds
ENABLE	BOOL	1	Enable bit

Description
When ENABLE = 1 call this function, to change the value of the system time with the value currently available on the inputs

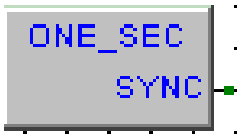
Date_write: write the current date



Parameter	Data Type	Dimension	Description
YY	UINT	8	Year
MM	UINT	8	Mounth
DD	UINT	8	Day
ENABLE	BOOL	1	Enable bit

Description
When ENABLE = 1, call this function to change the value of the system date with the value currently available on the inputs

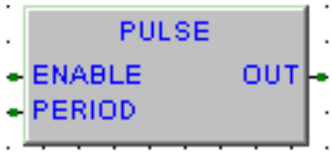
ONE_SEC: one second pulse



Parameter	Data Type	Dimension	Description
SYNC	BOOL	1	One second pulse

Description
Every one second, a pulse with a lifetime of a PLC cycle is generated.

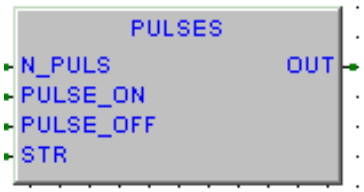
pulse



Parameter	Data Type	Dimension	Description
ENABLE	BOOL	1	Enable bit
PERIOD	UINT	16	Pulse duration
OUT	BOOL	1	Output pulse

Description
When ENABLE is 1, the output OUT is set to 1 for PERIOD ms

pulses

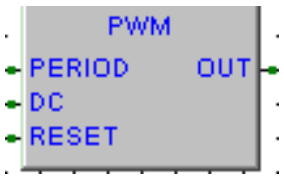


Parameter	Data Type	Dimension	Description
N_PULS	UINT	16	Number of output pulses
PULSE_ON	UINT	16	ON state of each pulse
PULSE_OFF	UINT	16	OFF state of each pulse

STR	BOOL	1	Enable input
OUT	BOOL	1	Output

Description When input STR detects a rising edge, on the output is present a train of N_PULS pulses, whose on state is equal to PULSE_ON ms and off state is equal to PULSE_OFF ms

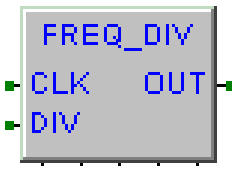
pwm



Parameter	Data Type	Dimension	Description
PERIOD	UINT	16	PWM period
DC	UINT	16	Duty cycle
RESET	UINT	16	Reset input
OUT	BOOL	1	Output

Description When RESET is set to 1, on the output is present a square wave whose period is equal to PERIOD and duty cycle is DC.

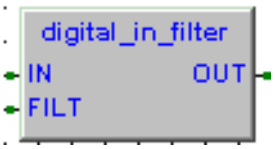
freq_div



Parameter	Data Type	Dimension	Description
CLK	BOOL	1	Input frequency
DIV	UINT	16	Division factor
OUT	BOOL	1	Output

Description Divides the input frequency by the factor value set on the DIV input.

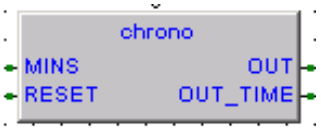
digital_in_filter



Parameter	Data Type	Dimension	Description
IN	BOOL	1	Input signal
FILT	UINT	16	Filtering factor
OUT	BOOL	1	Output

Description
If the input is stable for almost FILT number of PLC cycles, its value is propagated to the output

chrono



Parameter	Data Type	Dimension	Description
MINS	UDINT	16	Minutes set
START	BOOL	16	Start chrono
OUT	BOOL	1	Terminal count
OUT_TIME	UDINT	1	Time elapsed

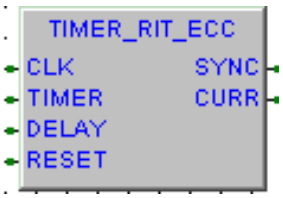
Description
When RESET is set to 1 and a rising edge is detected on the START input, the chrono starts to count until it reaches the value set on MINS input, then output OUT is set to 1. The count stop if RESET input is reset.

timer_retrig

Parameter	Data Type	Dimension	Description
CLK	UDINT	32	Clock input
TIMER	BOOL	1	Choose one of 128 available timers
DELAY	BOOL	1	Delay setup
RESET	UDINT	32	Reset timer
SYNC	BOOL	1	Terminal count output
CURR	UDINT	32	Counter current value

Description
RETRIGGERED DELAY INPUT TIMER
Starts the selected timer if on the CLK input is detected a rising edge and RESET is set to 1.
The timer works for a DELAY even if the CLK input goes 0 before the time is ended.
The output SYNC is set to 1 when the time is elapsed.
The timer is restarted if a new rising edge is detected on CLK input.

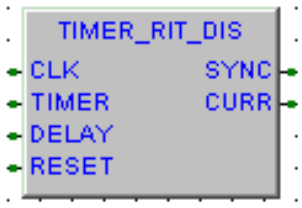
timer_rit_ecc



Parameter	Data Type	Dimension	Description
CLK	UDINT	32	Clock input
TIMER	BOOL	1	Choose one of 128 available timers
DELAY	BOOL	1	Delay setup
RESET	UDINT	32	Reset timer
SYNC	BOOL	1	Terminal count output
CURR	UDINT	32	Counter current value

Description
DELAY INPUT TIMER 1
Starts the selected timer if on the CLK input is detected a rising edge and RESET is set to 1.
The timer works for a DELAY time then it sets the SYNC output.
If the CLK input goes 0 before the time is elapsed the timer is reset.
The output SYNC is set to 1 when the time is elapsed.
The timer is restarted if a new rising edge is detected on CLK input.

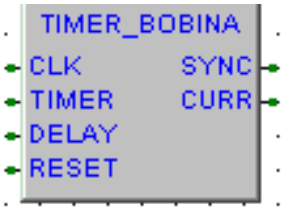
timer_rit_dis



Parameter	Data Type	Dimension	Description
CLK	UDINT	32	Clock input
TIMER	BOOL	1	Choose one of 128 available timers
DELAY	BOOL	1	Delay setup
RESET	UDINT	32	Reset timer
SYNC	BOOL	1	Terminal count output
CURR	UDINT	32	Counter current value

Description
DELAY INPUT TIMER 2
Starts the selected timer if on the CLK input is detected a falling edge and RESET is set to 1.
The timer works for a DELAY time then it sets the SYNC output.
If the CLK input goes 1 before the time is elapsed, the timer is reset.
The output SYNC is set to 1 when the time is elapsed.
The timer is restarted if a new falling edge is detected on CLK input.

timer_coil



Parameter	Data Type	Dimension	Description
CLK	UDINT	32	Clock input
TIMER	BOOL	1	Choose one of 128 available timers
DELAY	BOOL	1	Delay setup
RESET	UDINT	32	Reset timer
SYNC	BOOL	1	Terminal count output
CURR	UDINT	32	Counter current value

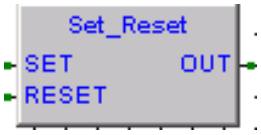
Description
RETRIGGERABLE COIL Starts the selected timer if on the CLK input is detected a rising edge and RESET is set to 1. The timer works for a DELAY even if the CLK input goes 0 before the time is ended. The output SYNC is set to 1 until the time is elapsed. The timer is restarted if a new rising edge is detected on CLK input.

r_trig

Parameter	Data Type	Dimension	Description
CLK	BOOL	1	Clock input
Q	BOOL	1	Output

Description
Q output is set when a rising edge is detected on the CLK input. Q is 0 when input CLK is 0

Set_Reset



Parameter	Data Type	Dimension	Description
SET	BOOL	1	Set input
RESET	BOOL	1	Reset input
OUT	BOOL	1	Output

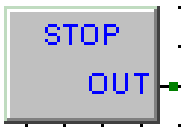
Description
Output is set to 0 if RESET input is 1, Output is set to 1 if input SET is 1

start

Parameter	Data Type	Dimension	Description
OUT	BOOL	1	Output set to 1

Description
Output is set to logic level 1

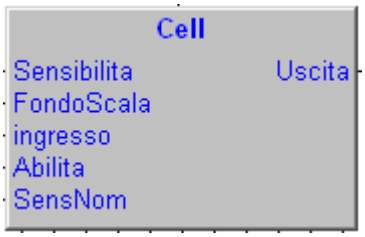
stop



Parameter	Data Type	Dimension	Description
OUT	BOOL	1	Output set to 0

Description
Output is set to logic level 0

Cell (Only TPAC 02 cell version)



Parameter	Data Type	Dimension	Description
Sensibilita	REAL	4	Cell Sensibility
FondoScala	REAL	4	Call range
Ingresso	REAL	4	Cell input (variables: from CELL_1 to CELL_4)
Abilita	BOOL	1	If 1, Enable function block
SensNom	REAL	4	Nominal sensibility of attached cell
Uscita	REAL	4	Measured weight

Description
If Abilita = TRUE the measured weight is based on: cell input, FondoScala, and Sensibilita.
The real sensibility is rated with Nominal sensibility of cell.

14.1 Embedded Functions

Name	**Description**
ABS	Absolute
ACOS	arcosine
ADD	Arithmetic addition
AND	Logical bitwise AND
ASIN	Arsine
ATAN	Arctangent
ATAN2	Arctangent of Y/X
CEIL	Ceiling of a value
COS	Cosine
COSH	Hyperbolic cosine
DIV	Arithmetic division
EQ	Equal
EXP	Base e exponential
FLOOR	Floor of a value
GE	Greater or equal
GT	Greater than
JMP	Jump
LE	Less or equal
LIMIT	Limit

Name	Description
LN	Natural logarithm
LOG	Base –10 logarithm
LT	Less than
MAX	Maximum value selection
MIN	Minimum value selection
MOD	Modulo operator
MOVE	Move
MUL	Arithmetic multiply
MUX	Multiplexer
NE	Not equal
NOT	Not
OR	Logical or
POW	Power
R	Boolean reset
RET	Return
ROL	Binary rotate left
ROR	Binary rotate right
S	Set
SEL	Selector
SHL	Binary shift left
SHR	Binary shift right
SINH	Hyperbolic sines
SQRT	Square root
SUB	Arithmetic subtraction
TAN	Tangent
TANH	Hyperbolic tangent
TO_BOOL	Conversion to BOOL
TO_DINT	Conversion to DINT
TO_INT	Conversion to Int
TO_REAL	Conversion to REAL
TO_SINT	Conversion to SINT
TO_UDINT	Conversion to UDINT
TO_UINT	Conversion to UINT
TO_USINT	Conversion to USINT
XOR	Logic XOR

15.0 HOW TO CONFIGURE TPAC THROUGH THE WEB INTERFACE

15.1 Preface

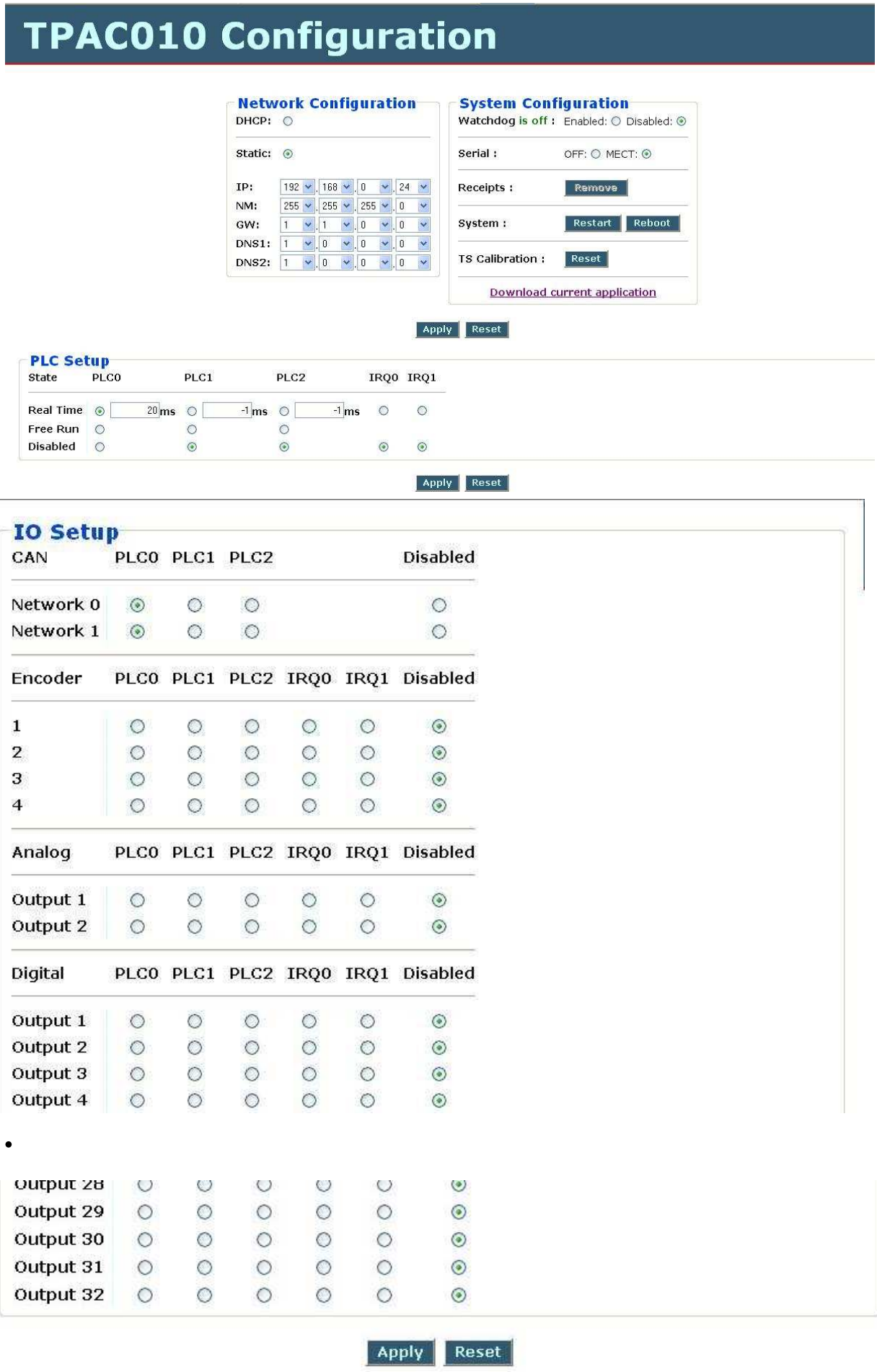
The TPAC has a set of parameters and devices that must be configured before their usage. Any Internet browser executes these configurations through a web interface.

15.2 Open TPAC web interface

The following example is based on the Internet Explorer browser version 6.0 (IE6). Switch on the TPAC and plug a network cable to connect the device to the local network; then, on a host pc, run IE6 and insert in the address field: ***http:// <IP address of TPAC>***.
The TPAC IP address assignment is described in the section **TPAC Configuration.**

After entering the IP address, press Enter, the TPAC responds by sending to the browser the web page shown in the picture below. The loaded web page contains the following section:

- **Network Configuration**
- **System Configuration**
- **PLC setup**
- **IO Setup**
- **IO Configuration**
- **IDs**


TPAC010 Configuration
Network Configuration
DHCP:
Static:
IP: 192 . 168 . 0 . 24
NM: 255 . 255 . 255 . 0
GW: 1 . 1 . 0 . 0
DNS1: 1 . 0 . 0 . 0
DNS2: 1 . 0 . 0 . 0
System Configuration
Watchdog is off : Enabled: Disabled:
Serial : OFF: MECT:
Receipts : Remove
System : Restart Reboot
TS Calibration : Reset
Download current application
Apply Reset
PLC Setup
State PLC0 PLC1 PLC2 IRQ0 IRQ1
Real Time 20 ms -1 ms -1 ms
Free Run
Disabled
Apply Reset
IO Setup
CAN PLC0 PLC1 PLC2 Disabled
Network 0
Network 1
Encoder PLC0 PLC1 PLC2 IRQ0 IRQ1 Disabled
1
2
3
4
Analog PLC0 PLC1 PLC2 IRQ0 IRQ1 Disabled
Output 1
Output 2
Digital PLC0 PLC1 PLC2 IRQ0 IRQ1 Disabled
Output 1
Output 2
Output 3
Output 4
Output 28
Output 29
Output 30
Output 31
Output 32
Apply Reset

15.3 Configuration

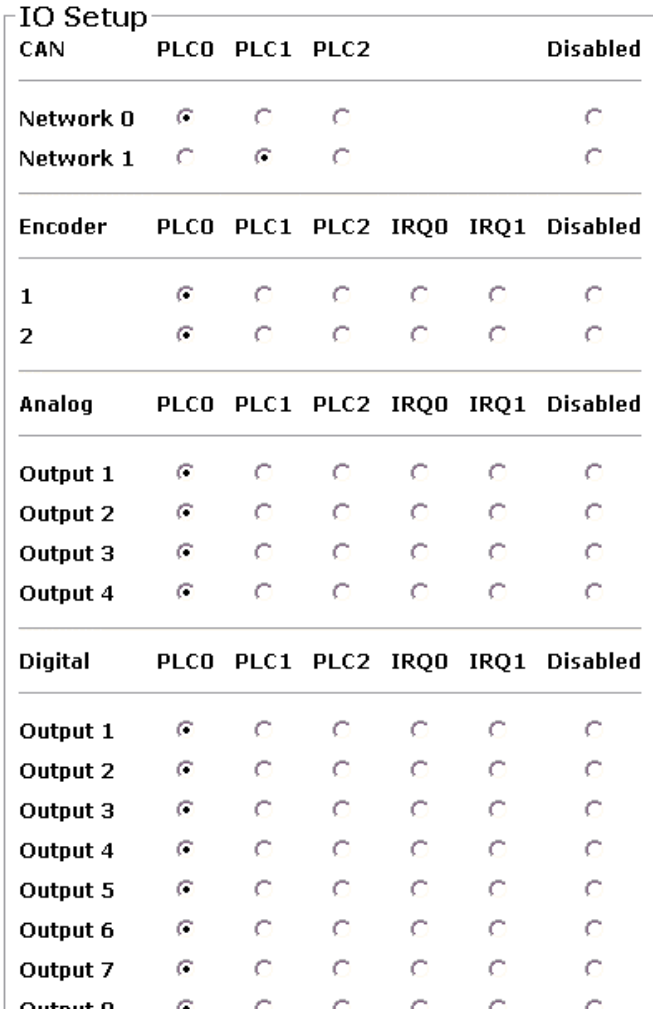
The **Network Configuration** section allows changing the IP address to which TPAC will reply after the next reboot.
The **System Configuration** section allows the activation of a number of parameters:

- The watchdog
- The MECT serial protocol
- The cancellation of the recipes saved on TPAC within a previous project
- The restart of the system
- The touch screen calibration
- The download of the PLC and HMI currently running on TPAC

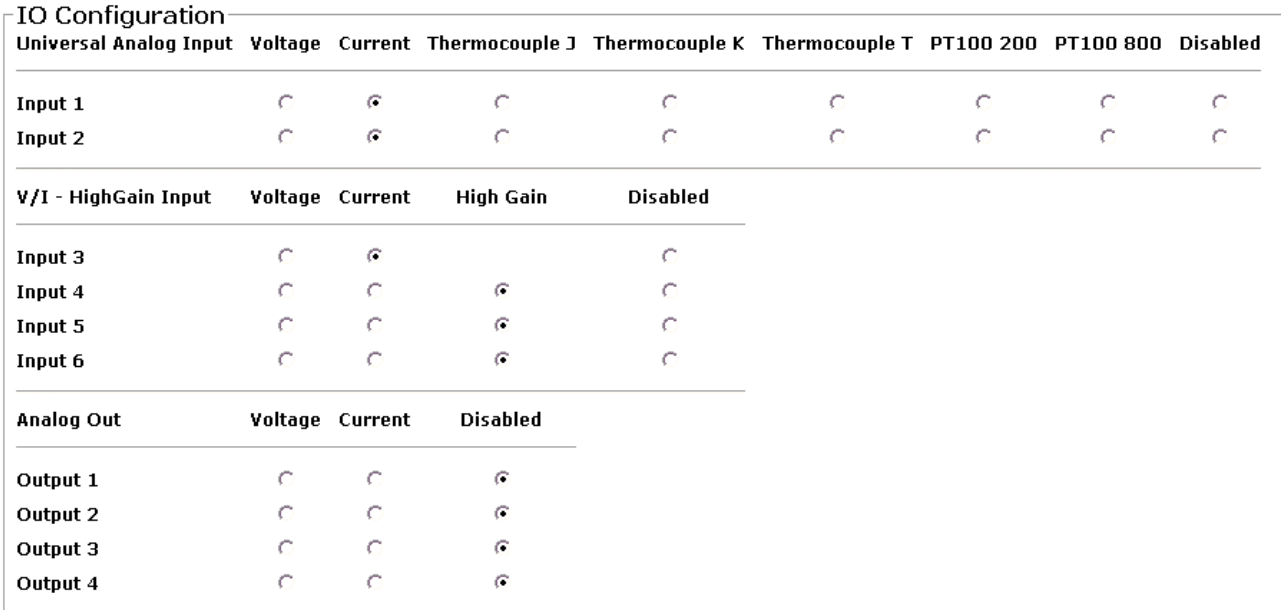
Section **PLC setup** allows to set the cycle time for each of the available PLC. Inserting the required time value for the PLC cycle in the available text box sets the cycle time: time value must be expressed in milliseconds. It worth to point out that only cycle times for effectively used PLC must be set; hence if you plan to use a single PLC, set the time cycle for PLC0 to the requested value and turn off the other two PLCs. Checking the box **Free Run** will make the corresponding PLC to run without a predetermined cycle time.
NOTE: A non-zero PLC cycle time for an unneeded one, lowers the overall system performances since a PLC uses CPU time.

An output device can be driven exclusively by a single PLC. The **IO Setup** section assigns analog outputs, digital output, CanOpen channels and encoders that each PLC is entitled to use.

In the following example the network CAN 0 is assigned to PLC 0 and network CAN 1 to PLC 1. If **Idle** is selected the corresponding CANOpen network will not be handled by TPC010. As mentioned earlier, a PLC can manage both CANOpen network, but it is unfeasible to assign a CANOpen network more than one PLC at the same time. Analog and digital outputs are subject to the same constraint.

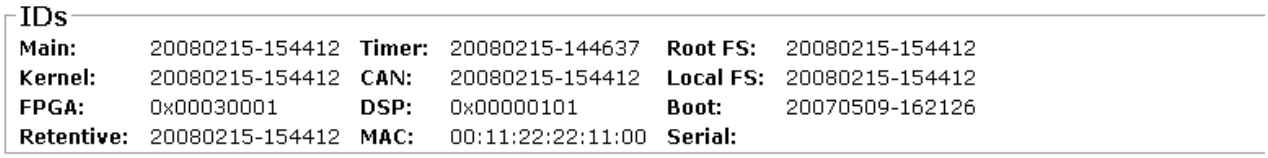


The **IO Configuration** section configures for both, digital and analogue channels, the kind of physical value detected (in the case of analog inputs) or generated (in the case of exits).



Once finished, press **Set values** to save the TPAC configuration parameters. On the next reboot configuration parameters will be automatically set.

The last section shows software and firmware revisions **IDs** for the system components.



16.0 FUNCTIONS

A number of functions are made available to control TPAC:

1. Immediate functions
2. Input delay functions
3. Timers
4. Video control functions
5. Receipts functions
6. Date and Time
7. MECT Serial
8. MODBUS RTU
9. CanOpen
10. HMI text file import
11. Data logger
12. Strings functions
13. Date sum and subtraction functions

16.1 IMMEDIATE FUNCTIONS

Into the PLC, outputs changing or inputs acquisition occur every cycle, but sometimes it is necessary to update the outputs as soon as possible without waiting the end of the cycle. In these cases there are available some functions called immediate, that update the outputs. These functions are listed below:

Name	**Description**	**Input parameters**
Imm_read_encoder	Reads the encoder value.	Parameters: encoder number -1.
	Example of encoder 2 read: read_value:= Imm_read_encoder(1);	Returns the read value if success, 0xffffffff if failure.
Imm_set_encoder	Sets the value of encoder counter.	Parameters: encoder number –1; preset value to set the encoder.
	Example to set the encoder 1 to 14322: result:= Imm_set_encoder(0,14322);	Returns 0, if success, 1 if failure.
Imm_set_encoder_mode	Sets the encoder counter mode.	Parameters: encoder number-1; mode to set the encoder.
	Example of set the mode 3 on encoder 1: result:= Imm_set_encoder(0,3);	Returns 0 if success, other if failure.

Imm_read_digital_input	Reads the digital input value.	Parameters: input number-1.
	Example of read the input 45: read_val:= Imm_read_digital_input (44);	Returns the read value if success, 0xffff if failure.
Imm_read_digital_feedback	Reads the outputs state.	Parameters: (detecting output -1) / 2.
	Example of read of output 9 and 10 status: Read_val:= Imm_read_digital_feedback (4);	Returns the read value if success, 0xffff if failure.
Imm_write_digital_output	Sets the digital outputs.	Parameters: output number-1; setting value (0 1).
	Example of set 1 to the output 3: result:= Imm_write_digital_output (2,1);	Returns 0 if success, other if failure.
Imm_read_analog_I	Reads the analog input value.	Parameters: analog input - 1.
	Example of reading the analog input 2: Read_val:= Imm_read_analog_i (1);	Returns the read value if success, 0xffff if failure.
Imm_write_analog_o	Sets the analog output value.	Parameters: analog output number - 1; value (0 - 4095) to be writtne on the output.
	Example of write the value 100 on analog output 1: result:= Imm_write_analog_o (100,0);	Returns 0 if success, other if failure.

16.2 DELAY FUNCTIONS

To reduce the digital inputs sensibility, it is possible to make a digital filtering of inputs, that makes to consider reliable an input when it is stable for a while. The settling time is user defined. For each delayed input the programmer, must do two steps:

- set in the variable DEALY_DI[input], the delay time (in ms)
- call the function **di_delay_set(input).**

The input parameter must contain the delayed input. The inputs are numbered from 0 to 47.
Example of delaying the input 5 of 100ms:

DELAY_DI[4]:=100;
result:=di_delays_set(4);

In the example the function **di_delays_set()** returns 0 if succeed, it returns not zero value for failure.

16.3 TIMERS

A number of timers (128) are available for the programs.
When the programmer set the timers[j] variable with the required time (where j may be a value from 0 to 127), the timer starts to count, and on timeout the variable timers[j] is zeroed. To trigger the timer put a 1 into TIMERS_FLAG[j] variable.

16.4 VIDEO CONTROL FUNCTIONS

Some functions to directly control the video are available to the programmer.

Name	**Description**	**Input parameters**
LCDSS_set_timeout	Sets the the screensaver timeout, in second.	Parameters: Timeout of the sscreensaver.
	Example of set the timeout of the screensaver to 5 minutes: result:= LCDSS_set_timeout (300);	Returns 0 if success, other if fail.
LCDSS_get_timeout	Reads the screensaver timeout	Parameters: constant.
	Example of screensaver timeout reading: result:= LCDSS_set_timeout (0);	Returns the screensaver timeout value.
LCD_set_backlight	Sets the screen brightness from 0 to 100%.	Parameters: brightness of the screen;
	Example of setting the brightness to 54%: result:= LCD_set_backlight (54);	Returns 0 if success, other if fail.

LCD_get_backlight	Reads the screen brightness.	Parameters: constant.
	Example of reading the brightness: brightness:= LCD_get_backlight (0);	Returns the brightness value.
LCDSS_on	Switches on the screen.	Parameters: constant.
	Example of screen switch on: result:= LCDSS_on (0);	Returns 0 if success, other if fail.
LCDSS_off	Switches off the screen.	Parameters: constant.
	Example of screen switch off: result:= LCDSS_off (0);	Returns 0 if success, other if fail.
LCDSS_enable	Enables the screensaver.	Parameters: constant.
	Example of screensaver enabling: result:= LCDSS_enable (0);	Returns 0 if success, other if fail.
LCDSS_disable	Disables the screensaver.	Parameters: constant.

16.5 RECEIPTS FUNCTIONS

The receipts package has already been created by MECT. The programmer may use the available functions, or if needed, can create by himself receipts interface.

Name	**Description**	**Input parameters**
Rcpt_set_curr	Sets the parameter of current receipt.	Parameter: receipt name. Parameter: description.
	Example: result:=Rcpt_set_curr (ric_name, description); The ric_name parmeter contains the receipt namewhile the description contains the description of receipt.	Returns 0 if success, other if fail.
Rcpt_save_curr	Saves on flash memory the current receipt.	Parameter: constant.
	Example: result:=Rcpt_save_curr (0);	Returns 0 if success, other if fail.
Rcpt_clean_all	Deletes all the receipts saved.	Parameter: constant.
	Example: result:=Rcpt_clean_all (0);	Returns 0 if success, other if fail.

Rcpt_clean_list	Deletes the current receipt data.	Parameter: constant.
	Example: result:=Rcpt_clean_list (0);	Returns 0 if success, other if fail.
Rcpt_clean_curr	Deletes the current receipt data.	Parameter: constant.
	Example: result:=Rcpt_clean_curr(0);	Returns 0 if success, other if fail.
Rcpt_remove	Deletes from flash memory a receipt.	Parameter: the receipt name to delete.
	Example: result:=Rcpt_remove (ric_name); The variable ric_name contains the name of the receipt to be deleted.	Returns 0 if success, other if fail.
Rcpt_remove_all	Deletes from flash all the saved receipt.	Parameter: constant.
	Example: result:=Rcpt_remove (0);	Returns 0 if success, other if fail.
Rcpt_exists	Checks for the receipt name.	Parameter: the receipt name to search for.
	Example: result:=Rcpt_exists (ric_name); The variable ric_name contains the name of the receipt.	Returns 0 if success, other if fail.
Rcpt_get_first_set_curr	Returns the first receipt saved in the list and set it as current receipt.	Parameter: constant.
	Example: ric_name:=Rcpt_get_first_set_curr (0); The variable ric_name contains the name of the returned receipt.	Returns the name of receipt.
Rcpt_get_next_set_curr	Returns the next receipt in the receipts list on flash and set it as current receipt.	Parameter: constant.

	Example:
	address:=Rcpt_get_next_set_curr (0);
	ric_name:=address;
	The variable ric_name contains the receipt address.
		Returns the receipt addressor 0 if the end of receipt list is reached.

Rcpt_get_prev_set_curr	Returns the previous receipt in the receipts list on flash and set it as current receipt..	Parameter: constant.

	Example:
	address:=Rcpt_get_prev_set_curr (0);
	ric_name:=address;
	The variable ric_name contains the receipt address.
		Returns the address of receipt or 0 if the top of the receipt list is reached.

Rcpt_load_curr	Loads the current receipt parameters.	Parameter: the receipt name.
	Example: result:=Rcpt_load_curr (ric_name); The parameter ric_name contains the name of the receipt.	Returns 0 if success, other if fail.
Rcpt_set_curr_descr	Sets the description of current receipt.	Parameter: description.
	Example: result:=Rcpt_set_curr_descr (description); The parameter description contains the description of the receipt.	Returns 0 if success, other if fail.
Rcpt_get_curr_descr	Loads the current receipt description.	Parameter: constant.
	Example: description:=Rcpt_set_curr_descr (0); The variable description contains the returned description of the receipt.	Returns the description string.
Rcpt_add_ty_USInt_par	Adds an unsigned 8 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_USInt_par (0,PLC_var1,’length’,'mm');	Returns 0 if success, other if fail
Rcpt_add_ty_SInt_par	Adds a signed 8 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable

	Example: result:=Rcpt_add_ty_SInt_par (0,PLC_var2,'wide','mm');	Returns 0 if success, other if fail
Rcpt_add_ty_UInt_par	Adds an unsigned 16 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_UInt_par (0,PLC_var1,leng,'mm');	Returns 0 if success, other if fail
Rcpt_add_ty_Int_par	Adds a signed 16 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_Int_par (0,PLC_var2,wide,'mm');	Returns 0 if success, other if fail
Rcpt_add_ty_UDInt_par	Adds an unsigned 32 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_UDInt_par (0,PLC_var1,leng,'mm');	Returns 0 if success, other if fail
Rcpt_add_ty_DInt_par	Adds a signed 32 bit integer parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_Dint_par (0,PLC_var2,'wide,'mm');	Returns 0 if success, other if fail

Rcpt_add_ty_Real_par	Adds a Real parameter to the list.	Parameter: receipt list index Parameter: PLC variable name Parameter: Mnemonic associated to the variable Parameter: Measure Unit associated to the variable
	Example: result:=Rcpt_add_ty_Real_par (0,PLC_var,'speed','m/s');	Returns 0 if success, other if fail
Rcpt_get_ty_USInt_par	Reads an unsigned 8 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC_var1:=Rcpt_get_ty_USInt_ par (0);	Returns the read value.
Rcpt_get_ty_SInt_par	Reads a signed 8 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC_var2:=Rcpt_get_ty_SInt_pa r (1);	Returns the read value.
Rcpt_get_ty_UInt_par	Reads an unsigned 16 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC_var3:=Rcpt_get_ty_UInt_p ar (2);	Returns the read value.
Rcpt_get_ty_Int_par	Reads a signed 16 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC_var4:=Rcpt_get_ty_Int_par (3);	Returns the read value.
Rcpt_get_ty_UDInt_par	Reads an unsigned 32 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC _var5:=Rcpt_get_ty_UDInt_par (4);	Returns the read value.
Rcpt_get_ty_DInt_par	Reads an unsigned 32 bit parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC var6:=Rcpt_get_ty_DInt_par (5);	Returns the read value.
Rcpt_get_ty_Real_par	Reads Real parameter from receipt list.	Parameter: the parameter receipt index.
	Example: PLC var7:=Rcpt_get_ty_Real_par (6);	Returns the read value.
Rcpt_get_param_comment	Reads the parameter mnemonic	Parameter: the parameter receipt index.
	Example: ric_name:=Rcpt_get_param_com ment (6);	Returns the read string.
	Reads the parameter type.	Parameter: the parameter receipt index.

Rcpt_get_param_type	Reads the parameter type.	Parameter: the parameter receipt index.
Rcpt_get_param_type	Reads the measurement unit of parameter. Example: um:=Rcpt_get_param_type (6); Types list: 0 unsigned short (unsigned 8 bits) 1 signed short (signed 8 bits) 2 unsigned int (unsigned 16 bits) 3 signed int (signed 16 bits) 4 unsigned short (unsigne 8 bits) 5 signed double int (signed 32 bits) 6 unsigned double int (unsigned 32 bits) 7 float (real)	Parameter: the variable parameter receipt index. Returns the read string.
Rcpt_get_curr_descr	Reads the current receipt description. Example: description:=Rcpt_get_curr_descr(0);	Parameter: constant. Returns the receipt description.
Rcpt_get_curr_param_count	Reads the number of parameters into the receipt. Example: result:=Rcpt_get_curr_param_count(0);	Parameter: constant. Returns the number of parameters.
Rcpt_import	Bulk import of receipts from a usb device to the TPAC	Parameter: index that identifies the usb device and relative path to the directory where the receipts are stored.
	Example: Result:=Rcpt_import(1, temp/receipts);	Returns 0 on success, >0 for error
	Bulk export of recipts from TPAC to a usb device	Parameter: index that identifies the usb device and relative path to the directory where receipts will be saved.
	Example: Result:=Rcpt_export(1, temp/receipts);	Returns 0 on success, >0 on error

16.6 DATE AND TIME FUNCTIONS

Two functions allows to read and write current date.

Function Name	**Description/ Example**	**Input Parameters / Returned Value**
DateTimeRead	Example: Result:= DateTimeRead(0);	Updates the following variables: TIME_HH, TIME_MM, TIME_SS, DATE_YY, DATE_MM, DATE_DD
DateTimeWrite	Example: Result:= DateTimeWrite(0);	Updates the RTC time with values hold inside variables: TIME_HH, TIME_MM, TIME_SS, DATE_YY, DATE_MM, DATE_DD

16.7 MECT SERIAL FUNCTIONS

The TPAC can interface through serial connection (RS232 or RS485) MECT devices therefore four functions are offered that read device status or set their parameters.
These functions return a code indicating whether the operation was successful or not. The error code table is given below:
0 - ACK - success
1 - NACK
9 - Data format error
11 - TX ID error
12 - transmitted command code error
13 – transmitted integer value error
14 - transmitted hexadecimal value error
15 - TX error for a real value
16 - TX error on data type
21 - TX error
31 - RX BCC error
32 - timeout
33 - RX error
41 - incorrect received string
100 - unknown error

Function Name	**Description** **Example**	**Input Parameter/** **Returned Value**
MECT_H_sread	Read an hexadecimal variable from a MECT device	Input: **id**:INT: MECT device address; **command**: STRING: Command Code **dd**:UDINT: Number of digit required by the protocol (6 or 8)
		Output: INT: Returned error code
MECT_H_swrite	Write on a MECT device hexadecimal variable	Input: **id**:UINT: MECT device address; **command**: Command code **value**:UINT: Variable value **dd**:UDINT Number of digit required by the protocol (6 or 8)
		Output: Returned error code
MECT_sread	Read an ASCII variable from a MECT device	Input: **id**:INT: MECT device address; **command**: STRING: Command code **dd**:UDINT: Number of digit required by the protocol (6 or 8)
		Output: Returned error code
MECT_swrite	Write on a MECT device ASCII variable	Input: **id**:UINT MECT device address; **command**: Command code **value**:UINT: Variable value **dd**:UDINT Number of digit required by the protocol (6 or 8)
		Output: Returned error code

MECT_H_sread() Example
Read an hexadecimal value from serial port: error:=MECT_H_sread(1,'SW',6);
Retrieved data is stored in PLC_MECT_enq variable.
MECT_sread() Example
Read an ASCII value from serial port: error:=MECT_sread(1,'RO',6);
Retrieved data is stored in PLC_MECT_enq variable.

MECT_H_swrite() Example
Write an hexadecimal value on serial port: error:=MECT_H_swrite(1,'SW'16#0001,6);
MECT_swrite() Example
Write an ASCII value on serial port: error:=MECT_swrite(1,'SW'16#0001,6);

16.8 MODBUS Functions

TPAC implements the MODBUS master functionality. Communication is based on RS232 or RS485 serial support according to the MODBUS RTU protocol specification. MODBUS availability and serial communication paramenters are set through the TPAC web setup interface accessible by any web browser at *http:// < TPAC ip address>*.
The following MODBUS function are made available:
01 Read Coil Status
02 Read Input Status
03 Read Holding Registers
04 Read Input Registers
05 Force Single Coil
06 Preset Single Register
15 Force Multiple Coil
16 Preset Multiple Registers
22 Mask Write 4X Register
23 Read/Write 4X Registers

Name	Description/Example	Input parameters/ Returned value
MB_f01	Reads the ON/OFF status of discrete outputs (0X reference coils) in the slave. Function does not support boradcast.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting coil to be read (coil 1 actually addresses coil 0) **count**: UINT number of the coil to be read, max count allowed is 256
	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy Error: if any it's written in MODBUSstatus[1]; Values: Read data are stored in MODBUSdata array. MODBUSdata[0] = number of the read items MODBUSdata[i] = coil status 1 → ON , 0 → OFF from to lower to the higher adress requested.

MB_f02	Reads ON/OFF status of discrete inputs (1X reference) in the slave. Function does not support boradcast.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting input to be read (input 1 actually adresses input 0) **count**: UINT number of the input sto be read, max count allowed is 256.
	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1]; Values: Read data are stored in MODBUSdata array. MODBUSdata[0] = number of the read items MODBUSdata[i] = input status 1 → ON , 0 → OFF from to lower to the higher adress requested.
MB_f03	Read the holding registers in a slave and put data into an array. (4XXXX reference). Function does not support broadcast.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting register address to be read (register 40001 actually addresses register 40000) **count**: UINT number of register to be read limited to 256 **byteorder**: USINT data byte format (modbus rtu data byte are organized with HI byte first, but some controllers put LO byte first) 0 HI – LO order 1 LO – HI order

	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1]; Values: Read data are stored in MODBUSdata array. MODBUSdata[0] = number of the read items MODBUSdata[i] = register value
MB_f04	Read the holding registers in a slave and put data into an array. (4XXXX reference). Function does not support broadcast.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting register address to be read (register 30001 actually addresses register 30000) **count:** UINT number of register to be read limited to 256 **byteorder**: USINT data byte format (modbus rtu data byte are organized with HI byte first, but some controllers put LO byte first) 0 HI – LO order 1 LO – HI order
	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1]; Values: Read data are stored in MODBUSdata array. MODBUSdata[0] = number of the read items MODBUSdata[i] = register value
MB_f05	Forces either ON or OFF the referenced coil status. Function does support broadcast, in this case tha same coil refrence is forced in all the attached slave.	INPUT: **slave_addr**: UINT salve address **coil_addr**: UINT coil address **coil_state**: UINT 0 forces the coil status to OFF, 1 forces the coil status to ON

	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled1 if modbus is busy; Error: if any it's written in MODBUSstatus[1];
MB_f06	Preset a value into a single holding register (4X reference). When broadcast, the function presets the same register reference in all attached slaves.	INPUT: **slave_addr**: UINT slave address **reg_addr**: UINT register address to be referenced (register 40001 actually reference register 40000). Value to be written in the register is read from MODBUSdata[0]
	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1];
MB_f0F	Forces each coil (0X reference) in a sequence of coils to either ON or OFF. When broadcast the function forces the same coil references in all attached slaves.	INPUT: **slave_addr**: UINT slave address **coil_addr**: UINT coil starting address **coil_count**: UINT number of coils to be set Values to be set for coils are read from the MODBUS data array. MODBUSdata[i]: coil status (0→ OFF, 1→ON) MODBUSdata[0] → status for coil_addr MODBUSdata[1] → status for coil_addr +1 MODBUSdata[N] → status for coil_addr +N

	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1];
MB_f10	Preset values into a sequenze of holding registers (4X references). When broadcast the function presets the same register references in all attached slaves.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting register address **count**: UINT number of registers to be set Values to be set for coils are read from the MODBUS data array. MODBUSdata[0] → start_addr register value MODBUSdata[1] → start_addr+1 register value MODBUSdata[N] → start_addr + N register value
	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1];
MB_f16	Modifies the contents of a specified 4X register using a combination of an AND mask an OR mask and the register current contents. The function can be used to set or clear individual bits in the register. Broadcast is not supported.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT register address Mask values are read from MODBUSdata MODBUSdata[0] → AND mask MODBUSdata[1] → OR mask

	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1];
MB_f17	Performs a combination of one read and one write operation in a single modbus transaction. The function can write new contents to a group oa 4X registers and then return the contents of another group of 4X registers. Broadcast is not supported.	INPUT: **slave_addr**: UINT slave address **start_addr**: UINT starting address for the registers to be read **count**: UINT number of location to be read **reg_addr**: UINT starting address for the registers to be written **reg_count**: UINT number of the registers to be written **byteorder**: USINT data byte format (modbus rtu data byte are organized with HI byte first, but some controllers put LO byte first) 0 HI – LO order 1 LO – HI order Value to be written into registers are read from MODBUS dat array. MODBUSdata[0] → reg_addr register value MODBUSdata[1] → reg_addr + 1 register value MODBUSdata[N] → reg_addr + N register value

	Example:	OUTPUT: Returned value: UINT 0 if modbus request has been fulfilled 1 if modbus is busy; Error: if any it's written in MODBUSstatus[1]; Read values are stored in the MODBUSdata array. MODBUSdata[0] = number of the read elements. MODBUSdata[1] = start_addr register value MODBUSdata[2] = start_addr+1 register value MODBUSdata[N] = start_addr + N –1 register value.

MODBUS function example:

```
SLAVE_ADD:=1;
START_ADD:=40689;
COUNT:=12;
ORDER:=0;

IF MODBUSstatus[0] = 0 THEN
     MB_READ1:=MB_f03(SLAVE_ADDRESS, START_ADD, COUNT, ORDER);
END_IF;

IF MB_READ1 = 0  THEN
(* LINE FREQUENCY*)
     Hz:=MODBUSdata[5]/10;
(* POWER FACTOR*)
     PF_Tot:=TO_USINT(MODBUSdata[8]/10);
END_IF;
```

16.9 CanOpen FUNCTIONS

Two functions are given to read and write SDO on CanOpen network.
A code is returned indicating whether the operation was successful or not. The error code table is given below:
0 - OK
1 - Variable name invalid
2 – Not existent variable
3 - CAN channel number invalid
126 - Node is not in running state
127 - Operation not yet available

Function Name	**Description/ Example**	**Input Parameter / Returned Value**
SDORead	Read a variable from a CanOpen node through SDO	Input: **ch**: UINT:CanOpen Network (0 or 1) to poll **var_name**: STRING: String containing the variable name as defined in the CanOpen Netbuilder setup of the network
		Output: Error Code
SDOWrite	Write on a variable of a CanOpen node through SDO	Input: **ch**: UINT:CanOpen Network (0 or 1) to poll **var_name**: STRING: String containing the variable name as defined in the CanOpen Netbuilder setup of the network **data**: UDINT: Value to be written
		Output: Error Code

SDORead() Example
Read the variable pr80 from a node in the CanOpen network number 1.

```
IF can_var= 0 THEN
      ris:=SDORead(1,'pr80');
      can_var:=1;
END_IF;
IF ris =0 THEN
      IF SDOStatus > 0 AND can_var = 1 THEN
            count_can:=count_can+1;
            can_var:=0;
            PR80_2:=SDODATA;
      END_IF;
END_IF;
```

Since the node takes some time to respond to a request, the value read from the node by the **SDORead** function is stored in the **SDOData** variable, but is not immediately available. The programmer must therefore check **SDOStatus** variable, which is set to 0 as a result of the command, and goes to 1 when **SDOData** contains the value read from the node. **SDOStatus** goes back to zero after a reading of **SDOData.**

SDOWrite() Example

Write 100 in the pr81 variable for a CanOpen node on the network 0:

```
IF SDOStatus = 0 THEN
      ris:=SDOWrite(1,'pr81',100);
END_IF;
```

Before writing check that **SDOStatus** is zero meaning that previous write operation was successful.

16.10 HMI TEXT FILE IMPORT FUNCTIONS

To view one or more text files in a HMI project, call the function **HMItextLoad**. The function returns a code indicating whether the operation was successful or not. The error codes table is given below:
0 - Success
1 - Error reading file contents
2 - Invalid file name
3 - File does not exist
4 - File cannot be open

Function Name	**Description/ Example**	**Input Parameter / Returned Value**
HMItextLoad		Input: Filename Output: Error code

If the function returns zero, the variable **FILE_READ** contains the address of the read file. To display the file contents, create a string variable long enough to contain the file and assign the **FILE_READ** pointer to the created string.

The following example shows the usage of the **HMItextLoad** function: define the variable File_content as a 500 items STRING variable in which the file contents will be saved.
If a call to **HMItextLoad** returns zero assign the value in the **FILE_READ** variable to File_content, otherwise write an error message.

```
Result:= HMItextLoad('italian_instruction ');

IF Result =  0 THEN
      File_content:=FILE_READ;
ELSE
      File_content:=' file not available';
END_IF;
```

As a result of the previously described step the variable **File_content** may be either the content of read file or the error message. To display the **File_content** assign the variable to a TextBox in HMI entering the property "Assoc string".

16.11 DATALOGGER

This section details functions available to store data on a disc mounted on the external USB port, thus enabling the recording of variables values or events that occurred during the TPAC operation. The data are stored in text file easily readable into a spreadsheet program for further processing. Each function returns a code indicating whether the operation was successful or not. The fuctions and the error code table is given below:

Function Name	**Description**	**Input Parameter / Returned Value**

Datalog_start	Load the USB disk on the TPAC and check if the available space on the disk is enough for data logging.	Input: **BUFF_LENGHT** : UDINT Number of sample to log **CHANNELS:** UDINT Number of input to log **INDEX**: UINT identifier for the usb device to be used as storage area (from 1 to 4)
		Output: Error Code DINT -1 - OK -2 – Cannot load the USB disk -3 – Cannot estimate the free space available on USB disk -4 – Cannot create the directory to store logged data >=0 – MAX allowed BUFF_LENGHT
Datalog_get	Save a variable on the USB disk	Input: **LABEL** : STRING: String containing the tag to be associated the logged data i.e. the heading of the data column. **VALUE**: REAL: the name of the variable that is logged.
		Output: Error code: DINT * 0 - OK * 1 Error
Datalog_stop	Stop the logging and create the log file	Input: **FILE**: STRING: File name for the log file
		Output: Error Code: DINT: * 0 OK * >0 error

The programmer must calculate the space needed to store the data for the required time, giving that each sample stands for 100byte.

If there's the need to sample five variables every four seconds for three hours, the BUFF_LENGTH is
5variables * 3 * 3600seconds/4seconds = 13500

That means a free area on the USB disk at least of :

100byte * 5variables * 3 * 3600seconds/4seconds = 1350000 bytes.

If after three hours the sampling process is not stopped, data acquired earlier will be overwritten following a circular buffer logic.

If you run the Dalaog_start () function and there's no enough free space on the USB disk to host the requested number of samples, the function returns the maximum number of samples allowable by the USB disk.

After the USB disk has been loaded and free available space evaluated, the Datalog_get() function is called with the required frequency (in the example once every four seconds). Input parameters for the Datalog_get() functions are the tag/label to associate to the logged data and the name of the variable to log.

When the samplig process is over, calling the Datalog_stop() function with the chosen log filename will output the log.
Sampled data will be available both, in the file given as input parameter for **Datalog_stop ()** and also in the **tempdata** directory where there's stored a file, whose name is the chosen tag, for each sampled variable.

Below an example of a program in ST, that acquires and saves data from two variables:

```
(************   variables                    ************)
VAL1:=(AIN_CH1-4.0)*600.0/16.0;
VAL2:=(AIN_CH2-4.0)*600.0/16.0;

(************   mounting disk                          ************)

IF state = 0 THEN
     num_ch:=2;                (*channel to sample*)
     acq_rate:=4;              (* sampling frequency, each 4 seconds*)
     acq_dur:=2;               (* acquisition duration 2 hours*)
     (* required_byte = 180000*)
     (* buffer_lenght = 1800*)

     buffer_lenght:=acq_dur*3600/ acq_rate;
     ris:=Datalog_start(buffer_lenght, num_ch);
     (* there should be at least required_byte of free space on the disk
     to honor buffer_lenght *)
     state:=1;
END_IF;

(************   setup samples number       ************)

IF  state = 1 THEN
     IF res < 0 THEN (* loading usb error*)
          state:=3;
     ELSIF res >0 THEN              (* free space is not enough *)
          max_camp:=res;
          state:=2 ;
     ELSE
          state:=2;
          max_camp:= buffer_lenght;
     END_IF;
     TIMERS[1]:=4000;
     samples:=0;
END_IF;

(************        data recording            ************)

IF state = 2 THEN
```

```
      IF  TIMERS[1]=0 AND samples < max_camp THEN
            TIMERS_FLAG[1]:=1;
            samples:=samples+1;
            dummy:=Datalog_get('Temp_ch1',VAL1);
            dummy:=Datalog_get('Temp_ch2',VAL2);
      ELSIF samples >=max_camp THEN
            state:=4;
      END_IF;
END_IF;

(************        stop recording            ************)

IF state=4 THEN
      res:=Datalog_stop('data.txt');
      state:=5;
END_IF;

IF state=5 THEN
      IF  res=0 THEN
      state:=6;
      ELSIF res<0 THEN
            state:=7;
      END_IF;
END_IF;
```

16.11.1 CRYPTO-DATALOGGER – CFR21/11

Datalogger functionality is available also with full compliance to CFR21/11 standard.
The TPAC Crypto-Datalogger works as the previously described standard datalogger except that, data are ciphered in memory before being written to the storage media.
Decrypted data are available only to whom hold the cipher key and the authorization password used to log the data themselves, thus ensuring data integrity and protection. Once decrypted, data are available in text format for easy elaboration with a standard spreadsheet tool.

Name	**Description**	**Input Parameter / Returned Value**
CryptoDatalog_start	Connect the USB device to TPAC, check for the available free space and initialize the cipher.	Input: **BUFF_LENGHT** : UDINT space required to save data on the usb device **CHANNELS:** UINT number of variables to be logged **INDEX**: UINT identifier for the usb device (from 1 to 4) to be used as storage area **KEY:** STRING 16 characters cipher key **PWD:** STRING 8 characters password

		Output: Error code DINT -1 - OK -2 – USB device cannot be accessed -3 – Cannot estimate the free space on the usb device -4 – Cannot create/cancel directory to save data >=0 - MAX number of byte available on the usb device
CryptoDatalog_get	Save crypted variable value on the usb device.	Input: **LABEL** : STRING: Label for the data to be saved used as heading of the data column **VALUE**: REAL: Value of the variable to be saved.
		Output: Error codes: INT * 0 - OK * 1 error
CryptoDatalog_stop	Stop Logging. The usb device contains in the directory tempdata/ the crypted datalog for each requested variable.	Input: costant
		Output: Error Code: UINT: * 0 OK * >0 error
CryptoDatalog_decrypt	Decrypt variables single datalogs and create the text full datalog .	Input: **FILE**: STRING full datalog filename **SRC_INDEX:** `UINT` identifier (from 1 to 4) for the usb device containing the source data **DST_INDEX:** `UINT` identifier (from 1 to 4) for the **KEY**: STRING 16 characters cipher key **PWD:** STRING 8 characters password
		Output: INT * 0 – OK * > 0 – Error
CryptoDatalog_eject	Unmount USB key	Input: **INDEX**: : UINT identifier for the usb device (from 1 to 4) to be used as storage area
		Output: INT * 0 – OK * > 0 – Cannot unmount USB device

16.12 STRINGS MANIPULATION FUNCTIONS

String manipulation is handled by two functions.

Function Name	**Description/ Example**	**Input parameter / Returned Value**
Str_concat()	Concatenates two strings	Input: **IN1**:STRING: string to which String2 is appended **IN2**:STRING: string to append to String1
		Output: BOOL: Function result FALSE OK TRUE FAIL
Str_inttostr()	Convert an integer into a string	Input: **X**:UDINT: integer to convert **DEST**:STRING: resulting string **WIDTH**:USINT: number of digit to be copied into the string **ZERI**:BOOL: set zero filling for missing digits
	Res:=Str_inttostr(34,string1,3,TRUE); Result: string1 will be '034'	Output: BOOL: function result FALSE OK TRUE FAIL

Example: Str_concat():
Define the two strings, String1 and String2, to be appended and an integer that stores function result.

```
String1:='abc';
String2:='defg';
Res:=Str_concat(String1,String2);
```

When Res = 0 Sgring 1 will be 'abcdefg'

Example: Str_inttostr():
Define a string and an integer value that stores function result.

Convert to string the number 34 with the result expressed in three digits; zeros make the string completion.

```
Res:=Str_inttostr(34,string1,3,TRUE);
```

When Res=0 String1 will be:'034'

16.13 DATE FUNCTIONS

Two functions handle date manipulation by adding an offset or calculating the difference between given dates.

Function Name	**Description/ Example**	**Input Parameter / Returned Value**

Date_add()	Add an offset expressed in days, weeks, months or year to a give date and return a string congaing the calculated date.	**TYPE**: STRING: offset type 'D' Days, 'W' Weeks, 'M' Months, 'Y' Year, to be added to date represented by the string START. **START**:STRING string representing the starting date to which offset will be added to. Date format is: DD-MM-YYYY **OFFS**:UDINT: offset value
		Output: STRING: string that contains the resulting date.
Date_diff()	Calculate the difference between two dates, and returns a value expressed in days, weeks, months or years.	**START**: STRING: first date **END**: STRING: second date **TYPE**: STRING: result type time unit
		Output: DINT: Contains the difference between first and second date expressed in the chosen result type time unit.

Example Date_add()
Define a string to contain the function result.
Add 2 weeks to the date expressed as DD-MM-YYYY.

```
String1:=Date_add('W','06-03-2008',2);
```

String1 will be: '20-03-2008'.

In case of a wrong intial date format (i.e. the initial date is expressed as MM-DD-YYYY instead of DD-MM-YYYY) the result string String1 will contain 'Error'.

Example Date_diff()
Define a DINT variable to contain the function result.
Calculate how many days there are between the '25-03-2008' and '18-03-2008'.

```
Res:=Date_diff('25-03-2008', '18-03-2008','D') ;
```
Res will be –8.

17.0 TPAC Remote Options

Starting from software release 3.0 TPAC10 includes the following new features:

- Remote Desktop : remote access to HMI interface
- Monitor: PLC variables state monitoring
- Remote PLC: remote PLC creation or remote intercation with on-board PLC to mange system's I/O.

The above mentioned features are accessible through LAN interface hence a valid IP configuration must be provided to the operator panel; access through WAN is granted by means of proper virtual private network configuration.

NOTE: Hereafter TPAC remote options will be exemplified assuming the default TPAC IP address: 192.168.0.210. During normal operations TPAC default IP address must be replaced by the address assigned on your own LAN.

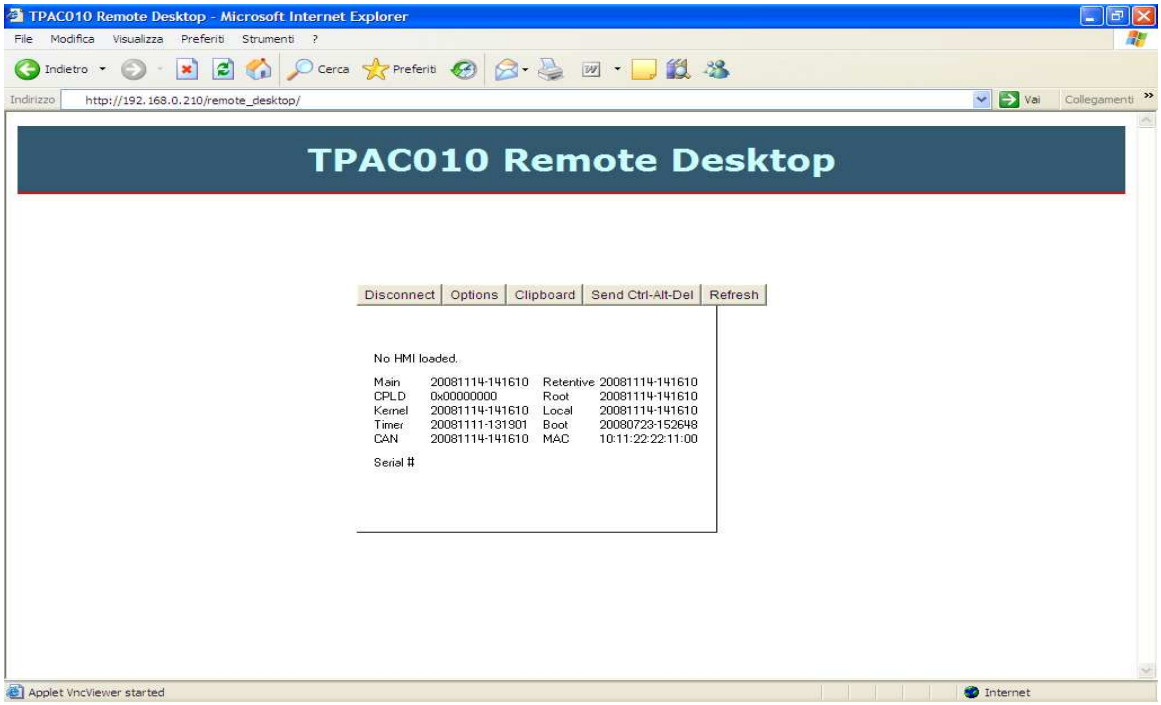
17.1 Remote Desktop

The TPAC offers remote WEB access to the HMI environment allowing the final users to interact with the HMI by their computer mouse like if they were working directly on the TPAC touchscreen interface.

17.2 Remote Desktop Access

To access remote desktop features open the browser (either Internet Explorer 6.0, Mozilla Firefox 2.0 or higher) and type in the address bar the following URL:
http://192.168.0.210/remote_desktop/

A web page like the one depicted below will appear. Insert the remote desktop access password and press OK. The fully functional HMI page currently displayed on the TPAC screen will be also visible and accessible by the mouse in the browser until when the “Disconnect” button is pressed.



17.3 Setting Remote Desktop Password

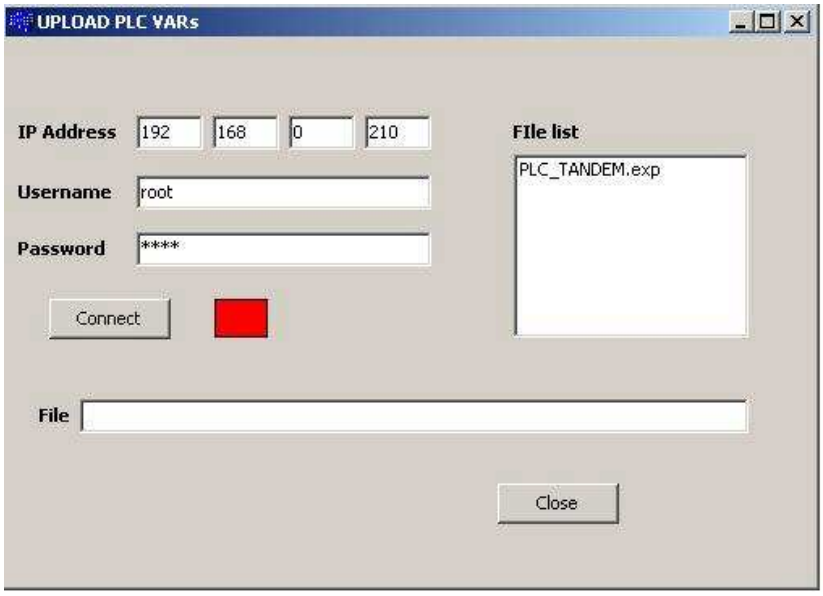
Remote Desktop default password is “root”. To set a different password follw the link “Set Password” available in the http://192.168.0.210/remote_desktop/ web page. In the displayed form insert the current password, the new password, retype the new password as confirmation and press button SET. The freshly changed password is immediatly active and must be used for the next log in. The remote desktop password never expires and can be changed whenever necessary.

17.4 Monitor

PLC variable’s values can be accessed through the monitor feature. Also programmer's plc variable and I/O status are made available.

17.5 Variables Upload

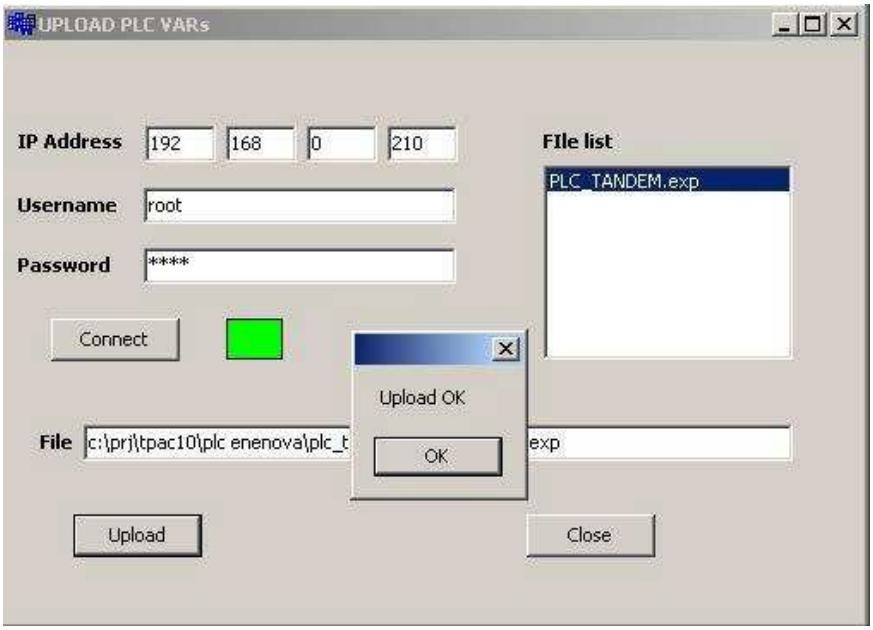
Before accessing PLC variables through the monitor feature the variables data set created by the PLC programmer must be exported to the TPAC.
When a plc project is compiled by LogicLab the tool creates also an “.exp” file that needs to be sent to the TPAC to synchronize the variables data set.
From LogicLab **Tools** menu chose **upload_var**, the following window will be displayed.



The UPLOAD PLC Vars window displays:

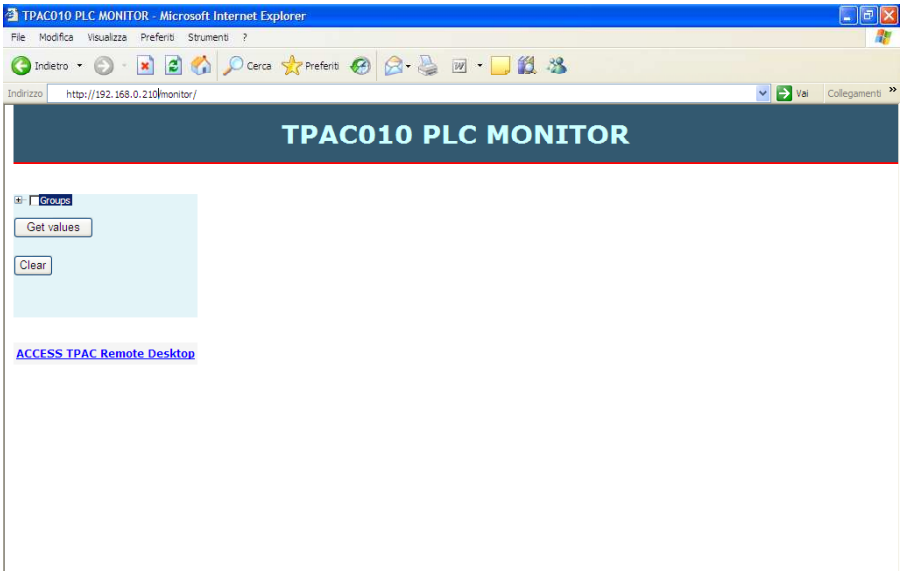
- the IP Address field that shows the IP already set for the current project connection, if necessary please modify the address with the IP of the TPAC where the variables data set needs to be exported.
- the username and password fields show the last credentials provided to access the TPAC, please change them according to your current TPAC configuration
- the field File List shows all the exp files in the current project directory.

Once the fields IP address, username and password are filled with the correct values click on the **Connect** button and wait until the red box becomes green which means the connection with the TPAC has been successfully established.
Select the "exp" file to be uploaded to the TPAC and press the **Upload** button. Upon successful completion, a messagge box "Upload OK" will be displayed.

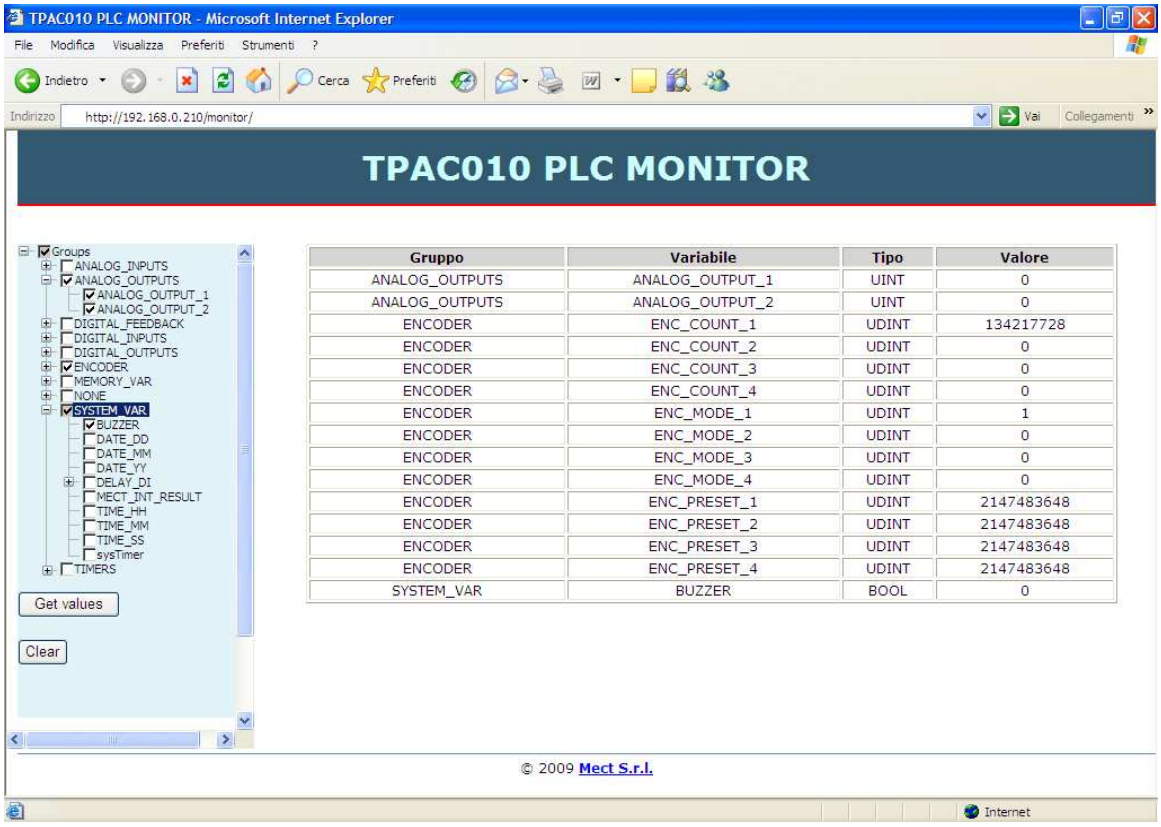


17.6 Monitor Access

To access the monitor feature type, in the browser address bar, the following address http://192.168.0.210/monitor/ . In the displayed web The left portion of the displayed page supplies the PLC variables and I/O list logically grouped as defined by the PLC programmer.



To view current I/O staus, variable's value as single or group expand the the tree and select the elements whose value is desidered. Selection are made by checking the box on the left side of the variable's name for single variable selection and by checking the group name for multiple selection. Press the button "GET VALUES " to retrieve the values/state for the selected items. To update the displayed values mantain or modify your selection and press the "GET VALUEs" button whenever needed.
The "CLEAR" button cancel the displayed values.



17.7 Remote PLC

The TPAC PLCLIB library allowes the programmer to:

1. Create a PC application that accesses the TPAC I/O system: analog/digital local input/output or CAN bus input/output.
2. Interact with the PLC program eventually already programmed for the panel by writing in a specific memory area.

PLCLIB is made available as windows dll in both OMF and COFF format.

17.8 PLCLIB Description

PLCLIB publishes through the plclib.h header the following data type and functions..

Data type

plcuservar_t

The plcuservar_t is used to allocate in memory the array containg all the PLC variables defined in the PLC program to which is directed the communication. Since the array is memory allocated it needs to be freed by the programmer when no more needed.
The array consist of structured items, defined as:

```
Typedef struct plcuservar {
      char name[32];
      char type[16];
}plcuservar_t;
```

The name of the variable is used to read/write it.
The detailed description of the meaning and the usage of each variables comes with the PLC documentation. The type of the variable can be used by the user to rapresent it.
The following variable type are available:

TYPE	DIMENSION (BYTE)	RANGE
BOOL	1	From 0 to 1
SINT	1	From –128 to +127
USINT	1	From 0 to 255
INT	2	From –32768 to + 32767
UINT	2	From 0 to 65535
DINT	4	From –2^31 to + 2^31 – 1
UDINT	4	From 0 to 2^32 – 1
BYTE	1	From 0 to 255
WORD	2	From 0 to 65535
DWORD	4	From 0 to 2^32 – 1
STRING[N]	N	‘\0’ Terminated string

17.9 Functions

Plc_init

NAME	plc_init
PROTOTYPE	int plc_init(char *hostname)
DESCRIPTION	Open the communication with the plc
PARAMETER	Char * hostname: is either the hostname or an IPv4 address in standard dot notation IP1.IP2.IP3.IP4
RETURED VALUE	• 0 on error; • the plc communication descriptor on success

Plc_release

NAME	plc_release
PROTOTYPE	int plc_release(int plcID)
DESCRIPTION	Close the communication with the plc.
PARAMETER	Int plcID: PLC communication descriptor returned by plc_init function.
RETURNED VALUE	• 0 on success • Negative on error

Plc_var_list

NAME	plc_var_list
PROTOTYPE	int plc_var_list(int plcID, plc_uservar_t **list)
DESCRIPTION	Provide the variables available from the PLC memory allocated in a plcuservar_t array.

PARAMETER	• Int plcID: plc communication descriptor • plcuservar_t ** pointer to the memory allocated variable array.
RETURNED VALUE	• number of the read variables on success • 0 or negative on error

Plc_var_read

NAME	plc_var_read
PROTOTYPE	int plc_var_read(int plcID, char *label void *data)
DESCRIPTION	attempts to read the variable named label into the data buffer provided by the user.
PARAMETERS	• Int plcID: plc communication descriptor • char * label : variable identifier • void *data : pointer to the buffer used to store the value of the variable named label
RETURNED VALUE	• 0 on success • negative on error

Plc_var_write

NAME	plc_var_write
PROTOTYPE	int plc_var_write(int plcID, char *label void *data)
DESCRIPTION	attempts to write the variable named label with the content of the data buffer provided by the user.
PARAMETERS	• Int plcID: plc communication descriptor • char * label variable identifier • void *data pointer to the buffer used to store the value of the variable named label
RETURNED VALUE	• 0 on success • negative on error

NOTE	When trying to write value to "read only" variables will cause errors. See PLC documentation for the list of writable variables. When interacting with the PLC already programmed on the panel the plc_var_write function must be used only to perform wirte in the RemoteArea. Writing on any of the other variables may results in unpredictable behaviour or errors.

17.10 Working with PLCIB in a Turbo C++ environment

PLCLIB required format to work with TurboC++ is OMF
Turbo C++ project must include the following files:

3. plclib.h – Header proiding the dll interface
4. plclib_omf.lib – dll import library, to be imported in the project or called by the directive
   `#pragma comment(lib, "plclib_omf.lib")`
5. plclib_omf.dll – Dll that will be called during program execution. To be copied in the same folder of the program executable.

17.11 VPN ACCESS CONFIGURATION

TPAC remote features can be accessed also from multiple networks by activating the already embedded VPN server. A Virtual Private Network (VPN) delivers private network services over a public infrastructure by means of authentication and content encryption to grant communication security. At a glance using the VPN service requires TPAC configuration and pc client/s installation and configuration.

To simplify VPN usage when security is not a major concern, the TPAC can adopt the provided standard VPN configuration both for the panel and the client; the latter is included in the installation cd along with the vpn client executable software.

If using the standard configuration the TPAC is accessible by vpn clients on the ip address 10.8.0.1. The connecting clients will requires the installation of openvpn-2.0.9-install.exe software ; furthermore one of the provided client configuration must be copied in the sub-directory config of the installation path.

When an ad hoc configuration is needed besides installing the vpn client software on the connetting clients a PKI (public key infrastructure) needs to be established The PKI grants the communication security through a separate certificate and private key for the server and each client, and a master Certificate Authority (CA) certificate and key which is used to sign each of the server and client certificates.

17.12 PKI setting up

From the installation CD copy the openvpn-2.0.9-install.exe file in any directory on the pc where you wish to install the client. Double click on the executable name, the installation wizard will guide you through the installation process. The default installation path is C:\Program Files\OpenVPN, you can change it if necessary.
Once installation has been completed the directory C:\Program Files\OpenVPN\easy-rsa contains all the tools needed to set up your PKI.

NOTE:
This tutorial is written assuming the installation path unchanged from the default proposed by the wizard.
OpenVPN will only run on Windows 2000 or later. Also note that OpenVPN must be installed and run by a user who has administrative privileges (this restriction is imposed by Windows, not OpenVPN). The restriction can be sidestepped by running OpenVPN in the background as a service, in which case even non-admin users will be able to access the VPN, once it is installed.

17.13 Certification authority

OpenVPN supports bidirectional authentication based on certificates, meaning that the client must authenticate the server certificate and the server must authenticate the client certificate before mutual trust is established. Both server and client will authenticate the other by first verifying that the presented certificate was signed by the master certificate authority (CA), and then by testing information in the now-authenticated certificate header, such as the certificate common name or certificate type (client or server).

From START->RUN… type "command" to open a DOS console window and cd to **C:**\Program Files\OpenVPN\easy-rsa**.** Run the following batch

```
> init-config
```

Now edit the **vars.bat** file and set the KEY_COUNTRY, KEY_PROVINCE, KEY_CITY, KEY_ORG, and KEY_EMAIL parameters. Don't leave any of these parameters blank. For example:

```
export KEY_COUNTRY="IT."
export KEY_PROVINCE="Italy"
export KEY_CITY="Turin"
export KEY_ORG="MyCompany"
export KEY_EMAIL= info@mycompany.com
```

Run the following commands:

```
> vars
> clean-all
> build-ca
```

The **clean –all** command will cancel any preexisting pki infrastructure while the final command **build-ca** will build the certificate authority (CA) certificate and key. Note that in the above sequence, most queried parameters were defaulted to the values set in the **vars.bat** files. The only parameter which must be explicitly entered is the **Common Name**, for example "MyCompanyCA". The certificate authority (CA) certificate ca.crt and key ca.key files are stored in C:\Program Files\OpenVPN\easy-rsa\2.0\keys

17.14 Session key

VPN connections require also a session key rebuilt by default each hour by using the parameters from the pem file. To get the parameter file cd to **C:**\Program Files\OpenVPN\easy-rsa**.** Run the following batch

```
> build-dh
```

The obtained dh1024.pem file is stored in C:\Program Files\OpenVPN\easy-rsa\2.0\keys

17.15 TPAC certificate and private key

Now we will generate a certificate and private key for the server. From the prompt console in the **C:**\Program Files\OpenVPN\easy-rsa directory run the following batch:

```
> build-key-server tpac010
```

As in the previous step, most parameters can be defaulted. When the **Common Name** is queried, enter "tpac010". Two other queries require positive responses, "Sign the certificate? [y/n]" and "1 out of 1 certificate requests certified, commit? [y/n]".

17.16 Client certifcate and key

Generating client certificates is very similar to the previous step. . From the prompt console in the **C:**\Program Files\OpenVPN\easy-rsa directory run the following batch:

```
> build-key my_pc
```

As in the previous step, most parameters can be defaulted. When the **Common Name** is queried, enter "my_pc". Again answer yes to the sign certificate query. You will obtain the ny_pc.crt and my_pc.key files respectively certificate and key for the client. Remember this step can be repeated to genereate as many as client certificate and key you need.

Now we need only to move all these configuration file in the proper directories to complete the VPN set up.

17.17 TPAC VPN Configuration

From the SAMPLE_VPN directory on the installation cd copy the sample_server.conf file.
Open the file with a text editor and modify it according to your needs. You are not allowed to change the used protocol (udp), the used device (tun) and the path and name for the server certificates and key. Once you are finished, rename the sample_server.conf file in tpac010.conf
Open your browser and type the following address http://192.168.0.210/vpn.cgi to access the vpn configuration upload page. Upload the following files:

- ca.crt
- dh1024.pem
- tpac010.key
- tpac010.crt
- tpac010.conf

17.18 Client VPN Configuration

From the SAMPLE_VPN directory on the installation cd copy the sample_client.conf file.Open the file with a text editor and modify it according to the server configuration and substitute in the following lines
cert ./client.crt
key ./client.key

the filename you ha chosen for the client certificate and key, in the above example “my_pc”

cert ./client.crt → cert ./my_pc.crt
key ./client.key → key ./my_pc.key

Also rename the sample_client.conf file with the COMMON NAME you have chosen for the client, in our example the client.conf file will be my_pc.conf.
Copy the following files:

- ca.crt
- my_pc.crt
- my_pc.key
- my_pc.conf

in the C:\Programmi\OpenVPN\config directory.
This completes your client configuration.
To configure more than one client install the vpn client (openvpn-2.0.9-install.exe) on each pc client and repeat steps outlined in paragraph 17.16 and 17.18 as many times as you need.

17.19 TPAC VPN address

If using the standard configuration TPAC VPN address is 10.8.0.1 otherwise the address is specified in the tpac010.conf file.

NOTE: if you require to contact by vpn connection the TPAC from external networks please be sure that your gateway allows udp communication on port 1194 and that such communication is redirected to the TPAC.

18.0 USB ALLOWED OPERATIONS

To expand the number of usb memory device actually pluggable into the panel, one and only one usb hub can be connected to the TPAC usb port. Four port hub usb device is the maximum expansion currently supported. The programmer retrieves the number and the working status of the available usb port through the USBstatus array, while the USBfeedback array reports the locked/unlocked status for the whole usb subsystem, i.e. availability to process the requested operation (cfr TPAC manual).
Permitted operation are between two usb device or on the same usb device itself:

- Copy file or directory
- Delete file or directory

Operations that refers to directory are performed recursively.

Name	**Description**	**Input Parameter / Returned Value**
Usb_copy	Copy the specified file in the specified destination. Copy the specified directory with	Input: **SRC** : STRING Path on the usb device for the file or directory to be copied **DST**: STRING Path on the usb device where the file or directory must be copied to **SRC_INDEX:** USINT identifier (from 1 to 4) for the usb device containing the source data **DST_INDEX:** USINT identifier (from 1 to 4) for the data destination usb device

		Output: Error code UINT * 0 – OK * 1 – Error
Usb_delete	Save crypted variable value on the usb device.	Input: **LABEL** : STRING: Label for the data to be saved used as heading of the data column **VAR**: REAL: Value of the variable to be saved.
		Output: Error codes: DINT * 0 - OK * 1 error
Usb_mkdir	Create a directory on the chosen usb device	**INDEX:** USINT identifier (from 1 to 4) of the target usb device
		Output: Error Code: UINT: * 0 OK * 1 error * 2 Directory already exists

19.0 APPENDIX 3

19.1 Software Registration

The development software
LogicLab
PageLab and
NetBuilder,

must be registered.

19.2 Registration code request for LogicLab, PageLabe and NetBuilder

The installation program, in its final stage, prompts the user a registration form that asks some personal details and the approval for the MECT newsletter subscription.

Once the form has been filled, by pressing the button Register an email will be sent to MECT. This email contains the registration code request for LogicLab, PageLab and NetBuilder software and the serial number of the hard disk where the installation has took place.

If the software installation has been completed on a PC with no Internet connection the aforementioned email must be copied and manually sent to MECT.

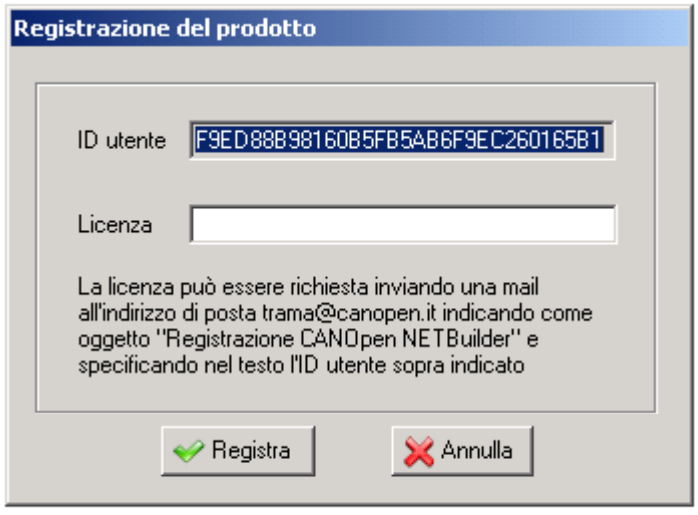
The registration step can be also performed after completing the installation through the register.exe program available on the installation CD. The program launches the to be filled registration form.
NOTE: register.exe execution must take place on the same PC where the development software has been installed.

19.3 LogicLab and PageLab registration

Once the registration code have been shipped, to register Axel software (**LogicLab** and **PageLab)** follow the instruction displayed in the registration window.

19.4 NetBuilder registration

When the code is shipped complete the registration by inserting the code in the registration form.


Registrazione del prodotto
ID utente
F9ED88B98160B5FB5AB6F9EC26016581
Licenza
La licenza può essere richiesta inviando una mail all'indirizzo di posta trama@canopen.it indicando come oggetto "Registrazione CANOpen NETBuilder" e specificando nel testo l'ID utente sopra indicato
Registra
Annulla

19.5 Software update

TPAC is based on different software that can be updated disjointedly.
Software can be grouped as follows:

1. System Software (the OS and libraries)
2. Services Software (configuration and settings for example the soft keyboard style)
3. User Software (PLC HMI program and Can network settings)

Software belonging to group 1 and 2 can be updated merely through USB pen.
Instead software described in group 3 can be updated through USB pen or LAN (by using the development tool LogicLAb, PageLab and NetBuilder)

19.5.1 System software update

MECT supplies to its customers system software update by means of a file named **sysupdate.sh**
To upgrade the TPAC user must copy the file **sysupdate.sh** on the USB, plug the pen in the usb port and then reboot the device. Updates will be automatically effective upon reboot completion.

Update files can be also loaded on the USB pen through the dashboard. Go through **Target**.. **Settings**, and then **Firmware upgrade**, a window for sysupdate.sh file selection will be displayed by pressing **Browse.** Once selected the update file it can be download on the USB pen by pressing **Export current configuration.**

19.5.2 Services software update

Services software includes all user modified software that is not specific to any project.
To update such files, like soft keyboard files pursue the following steps: build the update file on the PC (for example skbd.txt and skbd.gif), copy the new files on the USB pen and plug the pen on the TPAC and reboot the device. Updates become effective once the TPAC restarts.

19.5.3 User software update

User software groups all application software, PLC and HMI programs and CANOPen configuration.
Two kinds of possible TPAC users can be distinguished: the programmer and the final user.
The former can update programs running on the TPAC through the development tool PageLab, LogicLab and NetBuilder. The latter may not have the development environment or it can happens that the TPAC is used on equipments without Ethernet connection; in these cases update can be provided through the USB pen. Once the update file named sysupdate.sh is available, it must be copied on the USB pen. By restarting the TPAC with the USB pen plugged the device will automatically obtain the updates. Sysupdate.sh is built through the command **Download current application** available in the TPAC web interface.